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Semiworks Source Aggregate Area Management Study Report

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United States
Department of Energy

P.O. Box 550
Richland, Washington 99352



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ACRONYMS AND ABBREVIATIONS

AAMS	aggregate area management study
AAMSR	aggregate area management study reports
ARARs	applicable or relevant and appropriate requirements
ASIL	acceptable source impact level
BDAT	best demonstrated available treatment technologies
BWIP	Basalt Waste Isolation Project
CERCLA	Comprehensive Environmental Release, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
CMS	Corrective Measures Studies
DOD	Department of Defense
DOE	U.S. Department of Energy
DOE/RL	U.S. Department of Energy, Richland Operations Office
DQO	data quality objective
Ecology	Washington State Department of Ecology
EDTA	ethylenediamine tetraacetic acid
EPA	U.S. Environmental Protection Agency
ERA	expedited response actions
FFS	focused feasibility study
FS	feasibility study
FWQC	Federal Water Quality Criteria
GTR	Grout Treatment Facility
Health	State of Washington Department of Health
HEPA	high efficiency particulate air
HRS	Hazard Ranking System
HSDB	Hazardous Substance Database
HVAC	heating, ventilation, air conditioning
IRM	interim remedial measure
LFI	limited field investigation
MCL	maximum contaminant levels
MEPAS	Multimedia Environmental Pollutant Assessment System
mHRS	modified Hazard Ranking System
MSL	mean sea level
MTCA	Model Toxics Control Act
NAAQS	National Ambient Air Quality Standards
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List

NSPS	New Source Performance Standards
OSM	Office of Sample Management
PA	preliminary assessment
PARCC	Precision, Accuracy, Representativeness, Comparability, and Completeness
PA/SI	preliminary assessment/site inspection
PNL	Pacific Northwest Laboratory
PUREX	plutonium uranium extraction
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
RA	risk assessment
RAO	remedial action objective
RARA	Radiation Area Remedial Action
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
REDOX	reduction and oxidation
RI	remedial investigation
RFI	RCRA Facility Investigation
RLS	Radionuclide Logging System
ROD	record of decision
SARA	Superfund Amendments and Reauthorization Act
TBC	to-be-considered
TCLP	toxicity characteristic leaching procedure
TFSA&S	Tank Farm Surveillance Analysis & Support Group
TLD	thermoluminescent dosimeter
TRAC	Tracks Radioactive Components Inventory Program
TRU	Transuranic
TSD	treatment, storage or disposal
USC	U.S. Code
USGS	United States Geological Survey
WAC	Washington Administrative Code
WIDS	Waste Information Data System
WIPP	Waste Isolation Pilot Plant
WPPSS	Washington Public Power Supply System
Westinghouse Hanford	Westinghouse Hanford Company
WHC	Westinghouse Hanford Company

SEMI-WORKS SOURCE AAMS EXECUTIVE SUMMARY

This report presents the results of an aggregate area management study (AAMS) for the Semi-Works Aggregate Area in the 200 East Area of the U.S. Department of Energy (DOE) Hanford Site in Washington State. This scoping level study provides the basis for initiating Remedial Investigation/Feasibility Study (RI/FS) activities under CERCLA or RCRA Facility Investigations (RFI) and Corrective Measures Studies (CMS) under RCRA. This report also integrates select RCRA treatment, storage, or disposal (TSD) closure activities with CERCLA and RCRA past practice investigations.

Through the experience gained to date on developing work plans, closure plans, and permit applications at the Hanford Site, the parties to the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) have recognized that all past practice investigations must be managed and implemented under one characterization and remediation strategy, regardless of the regulatory agency lead (as defined in the Tri-Party Agreement). In particular, the parties have identified a need for greater efficiency over the existing RI/FS and RFI/CMS investigative approaches, and have determined that, to expedite the ultimate goal of cleanup, much more emphasis needs to be placed on initiating and completing waste site cleanup through interim measures.

This streamlined approach is described and justified in the *Hanford Federal Facility Agreement and Consent Order Change Package*, dated May 16, 1991 (Ecology et al. 1991). To implement this approach, the three parties have developed the *Hanford Site Past-Practice Strategy* (DOE/RL 1992) for streamlining the past practice remedial action process. This strategy provides new concepts for:

- Accelerating decision-making by maximizing the use of existing data consistent with data quality objectives.
- Undertaking expedited response actions and/or interim remedial measures, as appropriate, to either remove threats to human health and welfare and the environment, or to reduce risk by reducing toxicity, mobility, or volume of contaminants.

The *Hanford Site Past-Practice Strategy* (DOE/RL 1992) describes the concepts and framework for the RI/FS (or RFI/CMS) process in a manner that has a bias-for-action through optimizing the use of interim remedial actions, culminating with decisions on final remedies on both an operable-unit and aggregate-area scale. The strategy focuses on reaching early decisions to initiate and complete cleanup projects, maximizing the use

1 of existing data, coupled with focused short time-frame investigations, where necessary.
2 As more data become available on contamination problems and associated risks, the
3 details of the longer term investigations and studies will be better defined.
4

5 The strategy includes three paths for interim decision-making and a final remedy-
6 selection process for the operable unit that incorporates the three paths and integrates
7 sites not addressed in those paths. The three paths for interim decision-making include
8 the expedited response action (ERA), interim remedial measures (IRM), and limited
9 field investigation (LFI) paths. The strategy requires that aggregate area management
10 study reports (AAMSRs) be prepared to provide an evaluation of existing site data to
11 support initial path decisions. This AAMSR is one of ten reports that will be prepared
12 for each of the ten aggregate areas defined in the 200 Areas.
13

14 The near-term past practice strategy for the 200 Areas provides for ERAs, IRMs,
15 and LFIs for individual waste management units, waste management unit groups, and
16 groundwater plumes, and recommends separate source and groundwater operable units.
17 Initial site-specific recommendations for each of the waste management units within the
18 Semi-Works Aggregate Area are provided in the report. Work plans will initially focus
19 on limited intrusive investigations at the highest priority waste management units or
20 waste management unit groups as established in the AAMSR. The goal of this initial
21 focus is to establish whether interim remedial measures are justified. Waste management
22 units identified as candidate ERAs in Section 9.0 of the AAMS will be further evaluated
23 following the *Site Selection Process for Expedited Response Actions at the Hanford Site*
24 (Gustafson 1991).
25

26 While these elements may mitigate specific contamination problems through
27 interim actions, the process of final remedy selection must be completed for the operable
28 unit or aggregate area to reach closure. The aggregation of information obtained from
29 the LFIs and interim actions may be sufficient to perform the cumulative risk assessment
30 and to define the final remedy for the operable unit or aggregate area. If the data are
31 not sufficient, additional investigations and studies will be performed to the extent
32 necessary to support final remedy selection. These investigations would be performed
33 within the framework and process defined for RI/FS programs.
34

35 Several integration issues exist that are generic to the overall past practice process
36 for the 200 Areas and include the following:
37

38 **Future Work Plan Scope.** Although the current practice for implementing RI/FS
39 (RFI/CMS) activities is through operable unit based work plans, individual
40 LFI/IRMs may be more efficiently implemented using LFI/IRM-specific work
41 plans.
42

1 **Groundwater Operable Units.** A general strategy recommended for the 200 Areas
2 is to define separate operable units for groundwater affected by 200 Areas source
3 terms. This requires that groundwater be removed from the scope of existing
4 source operable units and new groundwater-specific operable units be established.
5 Recommendations for groundwater operable units will be developed in the
6 groundwater AAMSRs.

7
8 **Work Plan Prioritization.** Although priorities are established in the AAMSR for
9 operable units within the aggregate area, priorities between aggregate areas have
10 yet to be established. The integration of priorities at the 200 Areas level is
11 considered a prerequisite for establishing a schedule for past practice activities in
12 the 200 Areas.

13
14 It is intended that these integration issues be resolved following the completion of
15 all ten AAMSRs (Draft A) scheduled for September 1992. Resolution of these issues
16 will be based on a decisions/consensus process among EPA, Ecology, and DOE.
17 Following resolution of these issues a schedule for past practice activities in the 200
18 Areas will be prepared.

19
20 Background, environmental setting, and known contamination data are provided in
21 Sections 2.0, 3.0, and 4.1. This information provides the basis for development of the
22 preliminary conceptual model in Section 4.2 and for assessing health and environmental
23 concerns in Section 5.0. Preliminary ARARs (Section 6.0) and preliminary remedial
24 action technologies (Section 7.0) are also developed based on these data. Section 8.0
25 provides a discussion of the data quality objectives. Data needs identified in Section 8.0
26 are based on data gaps determined during the development of the conceptual model,
27 human health and environmental concerns, ARARs, and remedial action technologies.
28 Recommendations in Section 9.0 are developed using all the information provided in the
29 sections which precede it.

30
31 The Hanford Site, operated by the DOE, occupies about 1,450 km² (560 mi²) of
32 the southeastern part of Washington north of the confluence of the Yakima and
33 Columbia Rivers. The Hanford Site was established in 1943 to produce plutonium for
34 nuclear weapons using production reactors and chemical processing plants. The Semi-
35 Works Aggregate Area is located within the 200 East Area, near the middle of the
36 Hanford Site, and consists of a single operable unit (200-SO-1).

37
38 The Semi-Works 201-C Process Building and the Critical Mass Laboratory are the
39 two central features and key operational facilities of the aggregate area. The 201-C
40 Process Building was constructed in 1949 as a pilot plant for reprocessing reactor fuel
41 using the REDOX process. It was converted to a pilot plant for the PUREX process in
42 1954 and continued in this capacity until it was shut down in 1956. The 201-C Process

Building and associated support buildings were put back into operation in 1961 for the recovery of strontium from fission product waste. It has been inactive since 1967 and decommissioning activities began in 1983.

Criticality experiments and research were conducted at the Critical Mass Laboratory from 1960 to 1983. Currently the laboratory is closed, although the administrative offices are used.

The Semi-Works Aggregate Area contains a variety of waste disposal and storage facilities. High-level wastes were stored in underground tanks. Low-level wastes such as cooling and condensate water were allowed to infiltrate into the ground through cribs, ditches, and open ponds. Based on construction, purpose, or origin, the Semi-Works Aggregate Area waste management units fall into one of nine subgroups as follows:

- Two (Number of waste management units) Plants, Buildings, and Storage Areas
- Three Tanks and Vaults
- Seven Cribs and Drains
- One Reverse Well
- Two Ponds, Ditches, and Trenches
- Two Septic Tanks and Associated Drain Fields
- Three Transfer Facilities, Diversion Boxes, and Pipelines
- One Burial Site
- Four Unplanned Releases.

Detailed descriptions of these waste management units are provided in Section 2.3.

There are several ongoing programs that affect buildings and waste management units in the Semi-Works Aggregate Area (Section 2.7). These programs include RCRA and the Hanford Surplus Facilities Program. Four waste management units will be partially addressed by an ongoing program in addition to the actions recommended in the Semi-Works AAMS.

Discussions of surface hydrology and geology are provided on a regional, Hanford Site, and aggregate area basis in Section 3.0. The interpretation is based on a limited number of wells and this limitation does not support a detailed delineation of waste management unit-specific features. The section also describes the flora and fauna, land use, water use, and human resources of the 200 East Area and vicinity. Groundwater of the 200 East Area is described in detail in a separate Groundwater AAMSR.

A preliminary site conceptual model is presented in Section 4.0. Section 4.1 presents the chemical and radiological data that are available for the different media types, including surface soil, vadose zone soil, air, surface water, and biota; and site-specific data for each waste management unit and unplanned release.

A preliminary assessment of potential impacts to human health and the environment is presented in Section 4.2. This assessment includes a discussion of release mechanisms, potential transport pathways, and a preliminary conceptual model of human exposure based on these pathways. Physical, radiological, and toxicological characteristics of the known and suspected contaminants at the aggregate area are also discussed.

Health and environmental concerns are presented in Section 5.0. The preliminary qualitative evaluation of potential human health concerns is intended to provide input to the waste management unit recommendation process. The evaluation includes 1) an identification of contaminants of potential concern for each exposure pathway that is likely to occur within the Semi-Works Aggregate Area, 2) identification of exposure pathways applicable to individual waste management units, and 3) estimates of relative hazard based on four available indicators of risk—the CERCLA Hazard Ranking System (HRS) and modified HRS (mHRS), surface radiation survey data, and Westinghouse Environmental Protection Group site scoring.

Potentially applicable or relevant and appropriate requirements (ARARs) to be used in developing and assessing various remedial action alternatives at the Semi-Works Aggregate Area are discussed in Section 6.0. Specific potential requirements pertaining to hazardous and radiological waste management, remediation of contaminated soils, surface water protection, and air quality are discussed.

Preliminary remedial action technologies are presented in Section 7.0. The process includes identification of remedial action objectives (RAOs), determination of general response actions, and identification of specific process options associated with each option type. The process options are screened based on their effectiveness, implementability, and cost. The screened process options are combined into alternatives and the alternatives are described.

1 Data quality is addressed in Section 8.0. Identification of chemical and
2 radiological constituents associated with the units and their concentrations, with a view to
3 determine the contaminants of concern and their action levels, is a major requirement to
4 execute the *Hanford Site Past-Practice Strategy*. There was found to be a limited amount
5 of data in this regard. The section provides a summary of data needs identified for each
6 of the waste management units in the Semi-Works Aggregate Area. The data needs
7 provide the basis for development of detailed data quality objectives in subsequent work
8 plans.
9

10 Section 9.0 provides management recommendations for the Semi-Works
11 Aggregate Area based on the *Hanford Site Past-Practice Strategy*. Criteria for selecting
12 appropriate *Hanford Site Past-Practice Strategy* paths (ERA, IRM, and final remedy
13 selection) for individual waste management units and unplanned releases in the Semi-
14 Works Aggregate Area are developed in Section 9.1. As a result of the data evaluation
15 process, no waste management units were recommended for an ERA or an IRM; seven
16 units were recommended for LFIs which could lead to IRMs, and 18 units were
17 recommended for final remedy selection. A discussion of the data evaluation process is
18 provided in Section 9.2. Table ES-1 provides a summary of the results of the data
19 evaluation assessment of each unit. Table ES-2 provides the decision matrix patterns
20 each unit followed in reaching the recommendation. Recommendations for redefining
21 operable unit boundaries and prioritizing operable units for work plan development are
22 provided in Section 9.3. Included in Section 9.3 is a discussion of interactions with
23 RCRA. All recommendations for future characterization needs will be more fully
24 developed and implemented through work plans. Sections 9.4 and 9.5 provide
25 recommendations for focused feasibility and treatability studies, respectively.
26

Table ES-1. Summary of the Results of Remediation Process Path Assessment. (Sheet 1 of 3)

Waste Management Unit	ERA	IRM	LFI	RA	RI	OPS	Remarks
Plants, Buildings, and Storage Areas							
201-C Process Building					X		Structures have been stabilized under Hanford Surplus Facilities Program.
291-C Ventilation System					X		
Tanks and Vaults							
241-CX-70 Storage Tank					X		Tanks to be decontaminated and decommissioned under Hanford Surplus Facilities Program and closed under RCRA Program. Evaluations for post-closure care or remediation to be performed under Final Remedy Selection Path.
241-CX-71 Storage Tank					X		
241-CX-72 Storage Tank					X		
Cribs and Drains							
216-C-1 Crib		X	X				All cribs included under one analogous group. 216-C-1 Crib to be investigated as analogue site, with supplemental LFIs at 216-C-7 and 216-C-10 Cribs.
216-C-3 Crib		X	X				
216-C-4 Crib		X	X				
216-C-5 Crib		X	X				
216-C-6 Crib		X	X				
216-C-7 Crib		X	X				
216-C-10 Crib		X	X				
Reverse Wells							
216-C-2 Reverse Well					X		Unit has been decontaminated and decommissioned under Hanford Surplus Facilities Program.

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Table ES-1. Summary of the Results of Remediation Process Path Assessment. (Sheet 2 of 3)

Waste Management Unit	ERA	IRM	LFI	RA	RI	OPS	Remarks
Ponds, Ditches, and Trenches							
216-C-9 Pond					X		Unit has been decontaminated and decommissioned under Hanford Surplus Facilities Program.
200 East Powerhouse Ditch					X		To be removed from the Semi-Works operable unit and included as a waste management unit under B Plant AAMS.
Septic Tanks and Associated Drain Fields							
2607-E-5 Septic Tank and Drain Field					X		
2607-E-7A Septic Tank and Drain Field					X		
Transfer Facilities, Diversion Boxes, and Pipelines							
Semi-Works Valve Pit					X		Unit has been decontaminated and decommissioned under Hanford Surplus Facilities Program.
Critical Mass Laboratory Valve Pit					X		To be decommissioned under Hanford Surplus Facilities Program, then evaluated under Final Remedy Selection Path.
241-C-154 Diversion Box					X		Unit has been decontaminated and decommissioned under Hanford Surplus Facilities Program.
Burial Sites							
218-C-9 Burial Ground					X		
Unplanned Releases							
UN-200-E-36				X			
UN-200-E-37					X		

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Table ES-1. Summary of the Results of Remediation Process Path Assessment. (Sheet 3 of 3)

Waste Management Unit	ERA	IRM	LFI	RA	RI	OPS	Remarks
UN-200-E-98					X		
UN-200-E-141					X		

ERA - Expedited Response Action

IRM - Interim Remedial Measure

LFI - Limited Field Investigation

RA - Risk Assessment

RI - Remedial Investigation

OPS - Operational Programs

**Table ES-2. Semi-Works Aggregate Area Data Evaluation
Decision Matrix. (Sheet 1 of 2)**

	ERA Evaluation Pathway								IRM Evaluation Pathway			LFI Path	Final Remedy
Waste Management Unit	Hanford Site Past-Practice Strategy Criteria?	Release?	Pathway?	Quantity?	Concentration?	Treatment Available?	Adverse Consequences?	Operational Programs?	High Priority?	Data Adequate?	Adverse Consequences?	Collect Data?	Data Adequate?
Plants, Buildings, and Storage Areas													
201-C Process Building	N	—	—	—	—	—	—	—	N	—	—	—	N
291-C Ventilation System	N	—	—	—	—	—	—	—	N	—	—	—	N
Tanks and Vaults													
241-CX-70 Storage Tank	N	—	—	—	—	—	—	—	N	—	—	—	N
241-CX-71 Storage Tank	N	—	—	—	—	—	—	—	N	—	—	—	N
241-CX-72 Storage Tank	N	—	—	—	—	—	—	—	N	—	—	—	N
Crisbs and Drains													
216-C-1 Crib	Y	Y	N	—	—	—	—	—	Y	N	—	Y	—
216-C-3 Crib	Y	Y	N	—	—	—	—	—	N ^a	N	—	Y	—
216-C-4 Crib	Y	Y	N	—	—	—	—	—	N ^a	N	—	Y	—
216-C-5 Crib	Y	Y	N	—	—	—	—	—	N ^a	N	—	Y	—
216-C-6 Crib	Y	Y	N	—	—	—	—	—	N ^a	N	—	Y	—
216-C-7 Crib	Y	Y	N	—	—	—	—	—	N ^a	N	—	Y	—
216-C-10 Crib	Y	Y	N	—	—	—	—	—	Y	N	—	Y	—
Reverse Wells													
216-C-2 Reverse Well	Y	N	—	—	—	—	—	—	N	—	—	—	N
Ponds, Ditches, and Trenches													
216-C-9 Pond	Y	Y	N	—	—	—	—	—	N	—	—	—	N
200 East Powerhouse Ditch	N	—	—	—	—	—	—	—	N	—	—	—	N

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**Table ES-2. Semi-Works Aggregate Area Data Evaluation
Decision Matrix. (Sheet 2 of 2)**

Waste Management Unit	ERA Evaluation Pathway								IRM Evaluation Pathway			LFI Path	Final Remedy
	Hanford Site Past-Practice Strategy Criteria?	Release?	Path-way?	Quan-tity?	Concen-tration?	Treat-ment Available?	Adverse Conse-quences?	Opera-tional Pro-grams?	High Priority?	Data Ade-quate?	Adverse Conse-quences?	Collect Data?	Data Ade-quate?
Septic Tanks and Associated Drain Fields													
2607-E-5 Septic Tank and Drain Field	N	—	—	—	—	—	—	—	N	—	—	—	N
2607-E-7A Septic Tank and Drain Field	N	—	—	—	—	—	—	—	N	—	—	—	N
Transfer Facilities, Diversion Boxes, and Pipelines													
Semi-Works Valve Pit	N	—	—	—	—	—	—	—	N	—	—	—	N
Critical Mass Laboratory Valve Pit	Y	N	—	—	—	—	—	—	N	—	—	—	N
241-C-154 Diversion Box	N	—	—	—	—	—	—	—	N	—	—	—	N
Burial Sites													
218-C-9 Burial Ground	N	—	—	—	—	—	—	—	N	—	—	—	N
Unplanned Releases													
UN-200-E-36	N	—	—	—	—	—	—	—	N	—	—	—	Y
UN-200-E-37	N	—	—	—	—	—	—	—	N	—	—	—	N
UN-200-E-98	Y	Y	N	—	—	—	—	—	N	—	—	—	N
UN-200-E-141	Y	Y	N	—	—	—	—	—	N	—	—	—	N

N = No

Y = Yes

* Evaluated as high priority site because of proximity and/or similarity to other high priority sites.

ERA = Expedited Response Action

IRM = Interim Remedial Measure

LFI = Limited Field Investigation

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1.0 INTRODUCTION

The U.S. Department of Energy (DOE) Hanford Site in Washington State is organized into numerically designated operational areas including the 100, 200, 300, 400, 600, and 1100 Areas (Figure 1-1). The U.S. Environmental Protection Agency (EPA), in November 1989, included the 200 Areas of the Hanford Site on the National Priorities List (NPL) under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980. Inclusion on the NPL initiates the Remedial Investigation (RI) and Feasibility Study (FS) process for characterizing the nature and extent of contamination, assessing risks to human health and the environment, and selection of remedial actions.

This report presents the results of an aggregate area management study (AAMS) for the Semi-Works Aggregate Area located in the 200 Areas. The study provides the basis for initiating RI/FS under CERCLA or under the Resource Conservation and Recovery Act (RCRA) Facility Investigations (RFI) and Corrective Measures Studies (CMS). This report also integrates RCRA treatment, storage, or disposal (TSD) closure activities with CERCLA and RCRA past practice investigations.

This section describes the overall AAMS approach for the 200 Areas, defines the purpose, objectives and scope of the AAMS, and summarizes the quality assurance (QA) program and contents of the report.

1.1 OVERVIEW

The 200 Areas, located near the center of the Hanford Site, encompasses the 200 West, East, and North Areas which contain reactor fuel processing and waste management facilities.

Under the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement), signed by the Washington State Department of Ecology (Ecology), DOE, and EPA (Ecology et al. 1990), the 200 NPL Site encompasses the 200 Areas and selected portions of the 600 Area. The 200 NPL Site is divided into 8 waste area groups largely corresponding to the major processing plants (e.g., B Plant and T Plant), and a number of isolated operable units located in the surrounding 600 Area. Each waste area group is further subdivided into one or more operable units based on waste disposal information, location, facility type, and other site characteristics. The 200 NPL site includes a total of 44 operable units including 20 in the 200 East Area, 17 in the 200

1 West Area, 1 in the 200 North Area, and 6 isolated operable units. The intent of
2 defining operable units was to group associated waste management units together, so that
3 they could be effectively characterized and remediated under one work plan.

4
5 The Tri-Party Agreement also defines approximately 25 RCRA TSD groups within
6 the 200 Areas which will be closed or permitted (for operation or postclosure care) in
7 accordance with the Washington State Dangerous Waste Regulations (WAC 173-303).
8 The TSD facilities are often associated with an operable unit and are required to be
9 addressed concurrently with past-practice activities under the Tri-Party Agreement.

10
11 This AAMS is one of ten studies that will provide the basis for past practice
12 activities for operable units in the 200 Areas. In addition, the AAMS will be collectively
13 used in the initial development of an area-wide groundwater model, and conduct of an
14 initial site-wide risk assessment. Recent changes to the Tri-Party Agreement (Ecology et
15 al. 1991), and the *Hanford Site Past-Practice Strategy* document (DOE/RL 1992) establish
16 the need and provide the framework for conducting AAMS in the 200 Areas.

17 18 19 **1.1.1 Tri-Party Agreement**

20
21 The Tri-Party Agreement was developed and signed by representatives from the
22 EPA, Ecology, and DOE in May 1989, and revised in 1990 and 1991. The scope of the
23 agreement covers all CERCLA past practice, RCRA past practice, and RCRA TSD
24 activities on the Hanford Site. The purpose of the Tri-Party Agreement is to ensure that
25 the environmental impacts of past and present activities are investigated and
26 appropriately remediated to protect human health and the environment. To accomplish
27 this, the Tri-Party Agreement provides a framework and schedule for developing,
28 prioritizing, implementing, and monitoring appropriate response actions.

29
30 The 1991 revision to the Tri-Party Agreement requires that an aggregate area
31 approach be implemented in the 200 Areas based on the *Hanford Site Past-Practice*
32 *Strategy* (DOE/RL 1992). This strategy requires the conduct of AAMS which are similar
33 in nature to an RI/FS scoping study. The Tri-Party Agreement change package (Ecology
34 et al. 1991) specifies that 10 Aggregate Area Management Study Reports (AAMSR)
35 (major milestone M-27-00) are to be prepared for the 200 Areas. Further definition of
36 aggregate areas and the AAMS approach is provided in Sections 1.2 and 1.3.

37 38 39 **1.1.2 Hanford Site Past-Practice Strategy**

40
41 The *Hanford Site Past-Practice Strategy* was developed between Ecology, EPA, and
42 DOE to streamline the existing RI/FS and RFI/CMS processes. A primary objective of

1 this strategy is to develop a process to meet the statutory requirements and integrate
2 CERCLA RI/FS and RCRA Past Practice RFI/CMS guidance into a singular process for
3 the Hanford Site that ensures protection of human health and welfare and the
4 environment. The strategy refines the existing past practice decision-making process as
5 defined in the Tri-Party Agreement. The fundamental principle of the strategy is a bias-
6 for-action by optimizing the use of existing data, integrating past practice with RCRA
7 TSD closure investigations, focusing the RI/FS process, conducting interim remedial
8 actions, and reaching early decisions to initiate and complete cleanup projects on both
9 operable-unit and aggregate-area scale. The ultimate goal is the comprehensive cleanup
10 or closure of all contaminated areas at the Hanford Site at the earliest possible date in
11 the most effective manner.

12
13 The process under this strategy is a continuum of activities whereby the effort is
14 refined based upon knowledge gained as work progresses. Whereas the strategy is
15 intended to streamline investigations and documentation to promote the use of interim
16 actions to accelerate cleanup, it is consistent with RI/FS and RFI/CMS processes. An
17 important element of this strategy is the application of the observational approach, in
18 which characterization data are collected concurrently with cleanup.

19
20 For the 200 Areas the first step in the strategy is the evaluation of existing
21 information presented in AAMSR. Based on this information, decisions are made
22 regarding which strategy path(s) to pursue for further actions in the aggregate area. The
23 strategy includes three paths for interim decision making and a final remedy-selection
24 process that incorporates the three paths and integrates sites not addressed in those
25 paths. As shown on Figure 1-2, the three paths for decision-making are the following:

- 26
27 • Expedited response action (ERA) path, where an existing or near-term
28 unacceptable health or environmental risk from a site is determined or
29 suspected, and a rapid response is necessary to mitigate the problem
- 30
31 • Interim remedial measure (IRM) path, where existing data are sufficient to
32 indicate that the site poses a risk through one or more pathways and
33 additional investigations are not needed to screen the likely range of
34 remedial alternatives for interim actions; if a determination is made that an
35 IRM is justified, the process proceeds to select an IRM remedy and a
36 focused FS, if needed, to select a remedy
- 37
38 • Limited field investigation (LFI) path, where minimum site data are needed
39 to support IRM or other decisions, and is obtained in a less formal manner
40 than that needed to support a final Record of Decision (ROD). Data
41 generated from a LFI may be sufficient to directly support an interim

1 ROD. Regardless of the scope of the LFI, it is a part of the RI process,
2 and not a substitute for it.
3

4 The process of final remedy selection must be completed for the aggregate area to
5 reach closure. The aggregation of information obtained from LFI and interim actions
6 may be sufficient to perform the cumulative risk assessment and to define the final
7 remedy for the aggregate area or associated operable units. If the data are not sufficient,
8 additional investigations and studies will be performed to the extent necessary to support
9 final remedy selection. These investigations would be performed within the framework
10 and process defined for RI/FS or RFI/CMS programs.
11

12 13 1.2 200 NPL SITE AGGREGATE AREA MANAGEMENT STUDY PROGRAM 14

15 The overall approach and scope of the 200 Areas AAMS program is based on the
16 Tri-Party Agreement and the *Hanford Site Past-Practice Strategy*.
17

18 19 1.2.1 Overall Approach 20

21 As defined in the 1991 revision to the Tri-Party Agreement, the AAMS program
22 for the 200 Areas consists of conducting a series of ten AAMS for eight source (Figures
23 1-3 and 1-4) and two groundwater aggregate areas delineated in the 200 East, West, and
24 North Areas. Table 1-1 lists the aggregate areas, the type of study and associated
25 operable units. With the exception of 200-IU-6, isolated operable units associated with
26 the 200 NPL site (Figure 1-5) are not included in the AAMS program. Generally, the
27 quantity of existing information associated with isolated operable units is not considered
28 sufficient to require study on an aggregate area basis prior to work plan development.
29 Operable unit 200-IU-6 is addressed as part of the B Plant AAMS because of similarities
30 in waste management units (i.e., ponds).
31

32 The eight source AAMS are designed to evaluate source terms on a plant-wide
33 scale. Source AAMS are conducted for the following aggregate areas (waste area
34 groups) which largely correspond to the major processing plants including the following:
35

- 36 • U Plant
- 37
- 38 • Z Plant
- 39
- 40 • S Plant
- 41
- 42 • T Plant

- PUREX
- B Plant
- Semi-Works
- 200 North.

The groundwater beneath the 200 Areas is investigated under two groundwater AAMS on an Area-wide scale (i.e., 200 West and 200 East Areas). Groundwater aggregate areas were delineated to encompass the geography necessary to define and understand the local hydrologic regime, and the distribution, migration and interaction of contaminants emanating from source terms. The groundwater aggregate areas are considered an appropriate scale for developing conceptual and numerical groundwater models.

The U.S. Department of Energy, Richland Field Office (DOE/RL) functions as the "lead agency" for the 200 AAMS program. Depending on the specific AAMS, EPA and/or Ecology function as the "Lead Regulatory Agency" (Table 1-1). Through periodic (monthly) meetings information is transferred and regulators are informed of the progress of the AAMS such that decisions established under the *Hanford Site Past-Practice Strategy* (e.g., is an ERA justified?) (Figure 1-2) can be quickly and collectively made between the three parties. These meetings will continually refine the scope of AAMS as new information is evaluated, decisions are made and actions taken. Completion milestones for AAMS are defined in Ecology et al. (1991) and duplicated in Table 1-1. All AAMSR are submitted as Secondary Documents which are defined in the Tri-Party Agreement as informational documents.

1.2.2 Process Overview

Each AAMS consists of three steps: (1) the analysis of existing data and formulation of a preliminary conceptual model, (2) identification of data needs and evaluation of remedial technologies, and (3) conduct of limited field characterization activities. Steps 1 and 2 are components of the AAMSR. Step 3 is a parallel effort for which separate reports will be produced.

The first and primary task of the AAMS investigation process involves the search, compilation, and evaluation of existing data. Information collected for these purposes includes the following:

- Facility and process descriptions and operational histories for waste sources
- Waste disposal records defining dates of disposal, waste types, and waste quantities
- Sampling events of waste effluents and affected media
- Site conditions including the site physiography, geology, hydrology, meteorology, ecology, demography, and archaeology
- Environmental monitoring data for affected media including air, surface water, sediment, soil, groundwater, and biota.

Collectively this information is used to identify contaminants of concern, determine the scope of future characterization efforts, and to develop a preliminary conceptual model of the aggregate area. Although data collection objectives are similar, the types of information collected depend on whether the study is a source or groundwater AAMS. The data collection step serves to avoid duplication of previous efforts and facilitates a more focused investigation by the identification of data gaps.

Topical reports referred to as Technical Baseline Reports are initially prepared to summarize facility information. These reports describe individual waste management units and unplanned releases contained in the aggregate area as identified in the Waste Information Data System (WIDS) (WHC 1991a). The reports are based on review of current and historical Hanford Site reports, engineering drawings, and photographs and are supplemented with site inspections and employee interviews. Information contained in the reports is summarized in the AAMSR. Other topical reports are used as sources of information in the AAMSR. These reports are as follows:

- U Plant Geologic and Geophysics Data Package
- Z Plant Geologic and Geophysics Data Package
- S Plant Geologic and Geophysics Data Package
- T Plant Geologic and Geophysics Data Package
- PUREX Geologic and Geophysics Data Package
- B Plant Geologic and Geophysics Data Package
- 200 N Geologic and Geophysics Data Package

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- Semi-Works Geologic and Geophysics Data Package
- Hydrologic Model for the 200 West Groundwater Aggregate Area
- Hydrologic Model for the 200 East Groundwater Aggregate Area
- Unconfined Aquifer Hydrologic Test Data Package for the 200 West Groundwater Aggregate Area
- Unconfined Aquifer Hydrologic Test Data Package for the 200 East Groundwater Aggregate Area
- Confined Aquifer Hydrologic Test Data Package for the 200 Groundwater Aggregate Area Management Studies
- Groundwater Field Characterization Report
- 200 West Area Borehole Geophysics Field Characterization
- 200 East Area Borehole Geophysics Field Characterization

The general scope of the topical reports related to this AAMS is described in Section 8.0.

Information on waste sources, pathways, and receptors is used to develop a preliminary conceptual model of the aggregate area. In the preliminary conceptual model, the release mechanisms and transport pathways are identified. If the conceptual understanding of the site is considered inadequate, limited field characterization activities can be undertaken as part of the study. Field screening activities occurring in parallel with and as part of the AAMS process include the following:

- Expanded groundwater monitoring programs (non Contract Laboratory Program) at approximately 80 select existing wells to identify contaminants of concern and refine groundwater plume maps
- In situ assaying of gamma-emitting radionuclides at approximately 10 selected existing boreholes per aggregate area to develop radioelement concentration profiles in the vadose zone.

1 Wells, boreholes, and analytes are selected based on a review of existing
2 environmental data which is undertaken early in the AAMS process. Field
3 characterization results will be presented later in topical reports.

4
5 After the preliminary conceptual model is developed, health and environmental
6 concerns are identified. The purpose of this determination is to provide one basis for
7 determining recommendations and prioritization for subsequent actions at waste
8 management units. Potential applicable or relevant and appropriate requirements
9 (ARARs) and potential remedial technologies are identified. In cases where the existing
10 information is sufficient, the *Hanford Site Past-Practice Strategy* allows for a focused FS or
11 CMS to be initiated prior to the completion of the study.

12
13 Data needs are identified by evaluating the sufficiency of existing data and by
14 determining what additional data are necessary to adequately characterize the aggregate
15 area, refine the preliminary conceptual model and potential ARARs, and/or narrow the
16 range of remedial alternatives. Determinations are made regarding the level of
17 uncertainty associated with existing data and the need to verify or supplement the data.
18 If additional data are needed, the intended data uses are identified, data quality
19 objectives (DQO) established, and data priorities set.

20
21 Each AAMS results in management recommendations for the aggregate area
22 including the following:

- 23 • The need for ERA, IRM, and LFI or whether to retain in the final remedy
24 selection path
- 25 • Definition and prioritization of operable units
- 26 • Prioritization of work plan activities
- 27 • Integration of RCRA TSD closure activities
- 28 • The conduct of field characterization activities
- 29 • The need for treatability studies
- 30 • Identification of waste management units addressed entirely under other
31 operational programs.

32
33 The waste management units recommended for ERA, IRM, or LFI actions are
34 considered higher priority units that require rapid response. Lower priority waste
35 management units will generally follow the conventional process for RI/FS. In spite of
36
37
38
39

1 this distinction in the priority of sites, RI/FS activities will be conducted for all the waste
2 management units. In the case of the higher priority waste management units, rapid
3 response operations will be followed by conventional RI/FS activities, although these
4 activities may be modified because of knowledge gained through the remediation
5 activities. In the case of the lower priority waste management units, an Area-wide RI/FS
6 will be prepared which encompasses these sites.

7
8 Based on the AAMS, a decision is made on whether the study has provided
9 sufficient information to forego further field investigations and prepare a FS. An RI/FS
10 work plan (which may be limited to LFI activities) will be developed and executed. The
11 background information normally required to support the preparation of a work plan
12 (e.g., site description, conceptual model, DQO, etc.) is developed in the AAMSR. The
13 future work plans will reference information from the AAMSR. They will also include
14 the rationale for sampling and analysis, will present detailed, unit-specific DQO, and will
15 further develop physical site models as the data allows. In some cases, there may be
16 insufficient data to support any further analysis than is provided in the AAMSR, so an
17 added level of detail in the work plan may not be feasible.

18
19 All ten AAMSR are scheduled to be completed by September 1992. This will
20 facilitate a coordinated approach to prioritizing and implementing future past practice
21 activities for the entire 200 Areas.

22 23 24 **1.3 PURPOSE, SCOPE, AND OBJECTIVES**

25
26 The purpose of conducting an AAMS is to compile and evaluate the existing body
27 of knowledge and conduct limited field characterization work to support the *Hanford Site*
28 *Past-Practice Strategy* decision-making process for an aggregate area. The AAMS process
29 is similar in nature to the RI/FS scoping process prior to work plan development and is
30 intended to maximize the use of existing data to allow a more limited and focused RI/FS.
31 Deliverables for an AAMS consist of a AAMS report, health and safety plan, project
32 management plan, and information management overview.

33
34 Specific objectives of the AAMS include the following:

- 35
36 • Assemble and interpret existing data including operational and
37 environmental data
- 38
39 • Describe site conditions
- 40
41 • Conduct limited new site characterization work if data or interpretation
42 uncertainty could be reduced by the work (results from this work may not

be available for the AAMSR, but will be included in subsequent topical reports).

- Develop a preliminary conceptual model
- Identify contaminants of concern, and their distribution
- Identify potential ARARs
- Define preliminary remedial action objectives, screen potential remedial technologies, and if possible provide recommendations for focused FS
- Recommend treatability studies to support the evaluation of remedial action alternatives
- Define data needs, establish general DQO and set data priorities
- Provide recommendations for ERA, IRM, LFI, or other actions
- Redefine and prioritize, as data allow, operable unit boundaries
- Define and prioritize, as data allow, work plan and other past practice activities with emphasis on supporting early cleanup actions and records of decisions
- Integrate RCRA TSD closure activities with past practice activities.

Information on single-shell and double-shell tanks is presented in Sections 2.0 and 4.0. The AAMSR are not intended to address remediation related to the tanks. Nonetheless, the tank information is presented because known and suspected releases from the tanks may influence the interpretation of contamination data at nearby waste management units. Information on other facilities and buildings is also presented for this same reason. However because these structures are addressed by other programs, the AAMSR do not include recommendations for further action at these structures.

Depending on whether an aggregate area is a source or groundwater aggregate area, the scope of the AAMS varies. Source AAMSR focus on source terms, and the environmental media of interest include air, biota, surface water, surface soil, and the unsaturated subsurface soil. Accordingly, detailed descriptions of facilities and operational information are provided in the source AAMSR. In contrast, groundwater AAMS focus on the saturated subsurface and on groundwater contamination data. Descriptions of facilities in the groundwater AAMSR are limited to liquid disposal

1 facilities and reference is made to source AAMSR for detailed descriptions. The
2 description of site conditions in source AAMSR concentrate on site physiography,
3 meteorology, surface water hydrology, vadose zone geology, ecology, and demography.
4 Groundwater AAMSR summarize regional geohydrologic conditions and contain detailed
5 information regarding the local geohydrology on an area-wide scale. Correspondingly,
6 other sections of the AAMSR vary depending on the environmental media of concern.
7
8

9 1.4 QUALITY ASSURANCE

10
11 A limited amount of field characterization work is performed in parallel with
12 preparation of the AAMSR. To help ensure that data collected are of sufficient quality
13 to support decisions, all work will be performed in compliance with DOE Order 5700.6C,
14 Quality Assurance (DOE 1991) as well as Westinghouse Hanford's existing QA manual,
15 WHC-CM-4-2 (WHC 1988a) and with procedures outlined in the QA program plan,
16 WHC-EP-0383 (WHC 1990a) specific to CERCLA RI/FS activities. This QA program
17 plan describes the various plans, procedures, and instructions that will be used by
18 Westinghouse Hanford to implement the QA requirements. Standard EPA guidance
19 documents such as the *Contract Laboratory Program Statement of Work for Organic*
20 *Analysis* (EPA 1988a) will also be followed.
21
22

23 1.5 ORGANIZATION OF REPORT

24
25 In addition to this introduction, the AAMS consists of the following nine sections
26 and appendices:
27

- 28 • Section 2.0, Facility, Process and Operational History Descriptions,
29 describes the major facilities, waste management units and unplanned
30 releases within the aggregate area. A chronology of waste disposal
31 activities is established and waste generating processes are summarized.
32
- 33 • Section 3.0, Site Conditions, describes the physical, environmental, and
34 sociological setting including, geology, hydrology, ecology, meteorology, and
35 demography.
36
- 37 • Section 4.0, Preliminary Conceptual Model, summarizes the conceptual
38 understanding of the aggregate area with respect to types and extent of
39 contamination, exposure pathways and receptors.
40
- 41 • Section 5.0, Health and Environmental Concerns, identifies chemicals used
42 or disposed within the aggregate area that could be of concern regarding

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public health and/or the environment and describes and applies the screening process for determining the relative priority of follow-up action at each waste management unit.

- Section 6.0, Identification of Potentially Applicable or Relevant and Appropriate Requirements for the Semi-Works Aggregate Area, identifies federal and state standards, requirements, criteria, or limitations that may be considered relevant to the aggregate area.
- Section 7.0, Preliminary Remedial Action Technologies, identifies and screens potential remedial technologies and establishes remedial action objectives for environmental media.
- Section 8.0, Data Quality Objectives, reviews QA criteria on existing data, identifies data gaps or deficiencies, and identifies broad data needs for field characterization and risk assessment. The DQO and data priorities are established.
- Section 9.0, Recommendations, provides guidance for future past practice activities based on the results of the AAMS. Recommendations are provided for ERA at problem sites, IRM, LFI, refining operable unit boundaries, prioritizing work plans, and conducting field investigations and treatability studies.
- Section 10.0, References, lists reports and documents cited in the AAMS.
- Appendix A, Supplemental Data, provides supplemental data supporting the AAMS.

The following plans are included and will be used to support past practice activities in the aggregate area:

- Appendix B: Health and Safety Plan
- Appendix C: Project Management Plan
- Appendix D: Information Management Overview

Community relations requirements for the Semi-Works Aggregate Area can be found in the *Community Relations Plan for the Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989).

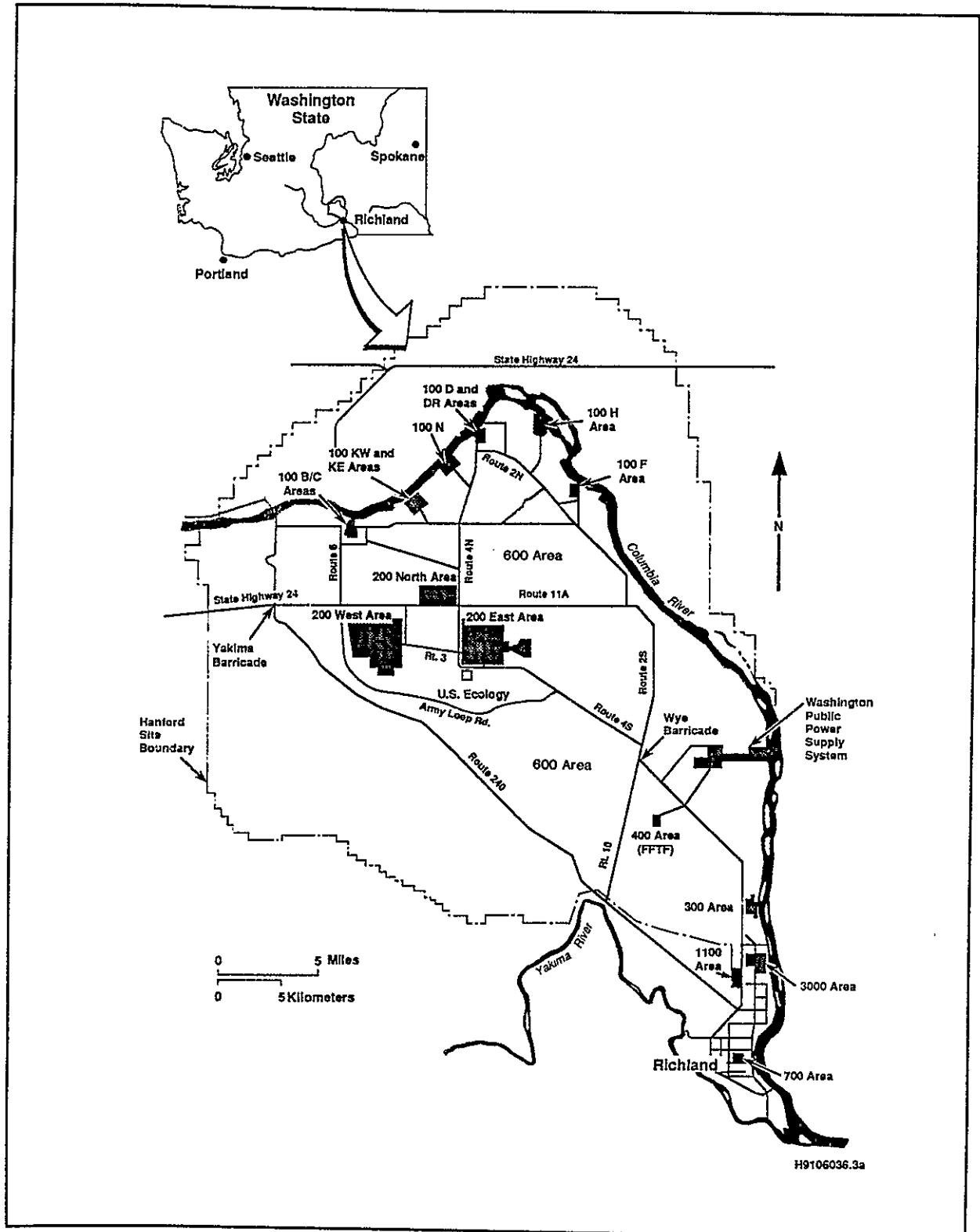
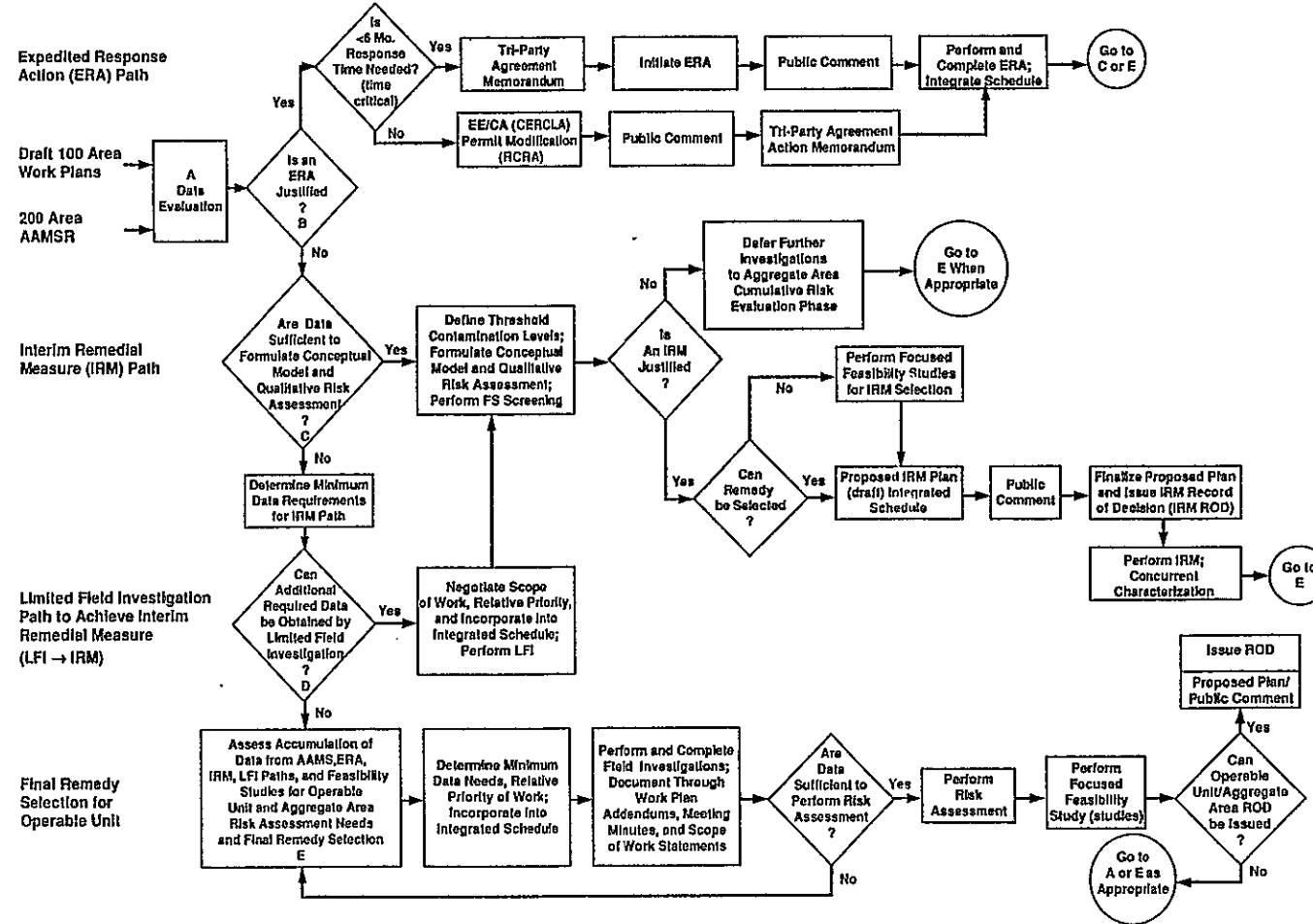


Figure 1-1. Hanford Site Map

Hanford Past Practice RI/FS (RFI/CMS) Process

The process is defined as a combination of interim cleanup actions (involving concurrent characterization), field investigations for final remedy selection where interim actions are not clearly justified, and feasibility/treatability studies.

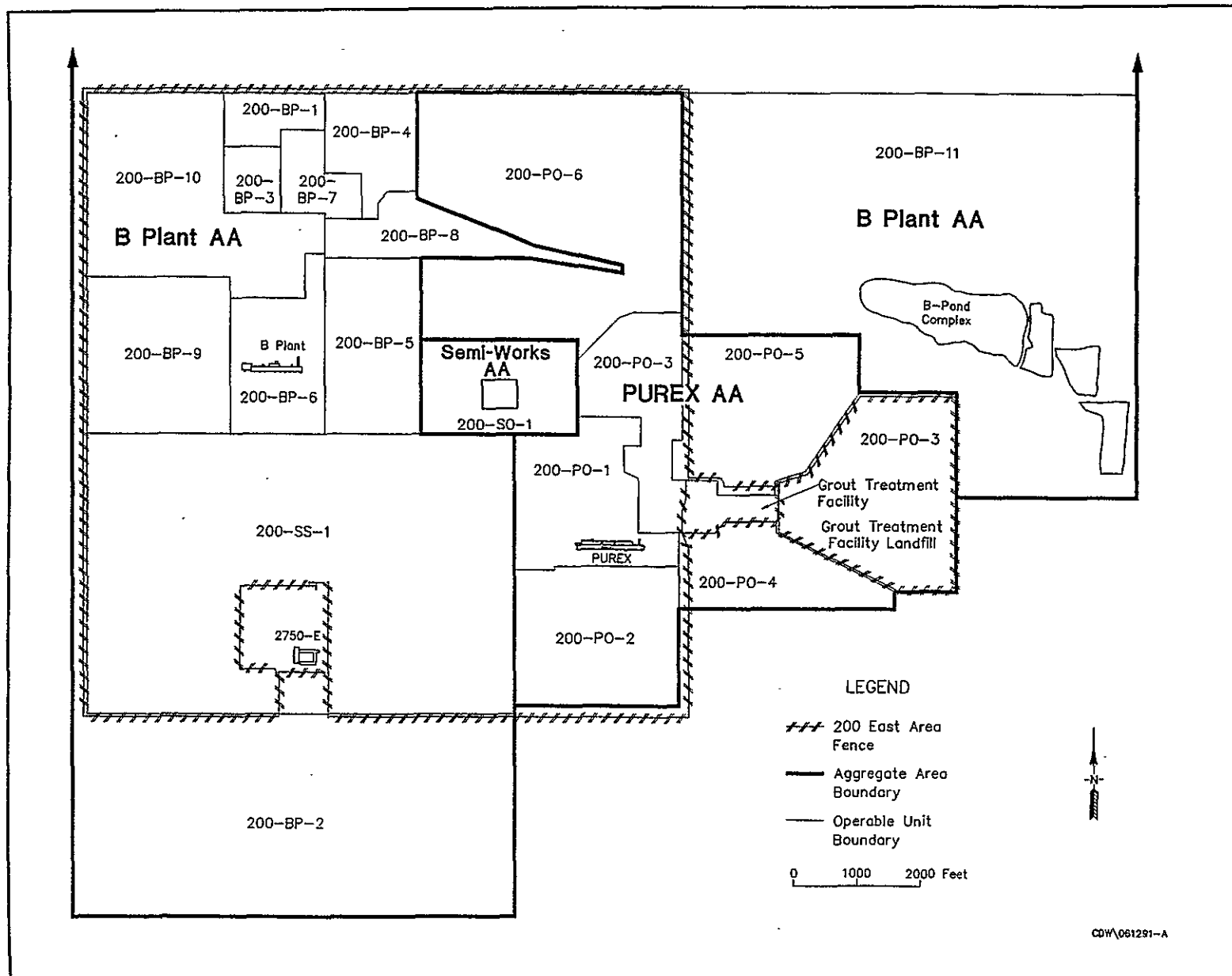


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Figure 1-2. Hanford Past-Practice Strategy Flow Chart.

(Source: Thompson 1991)

Figure I-3. 200 East Aggregate Areas.



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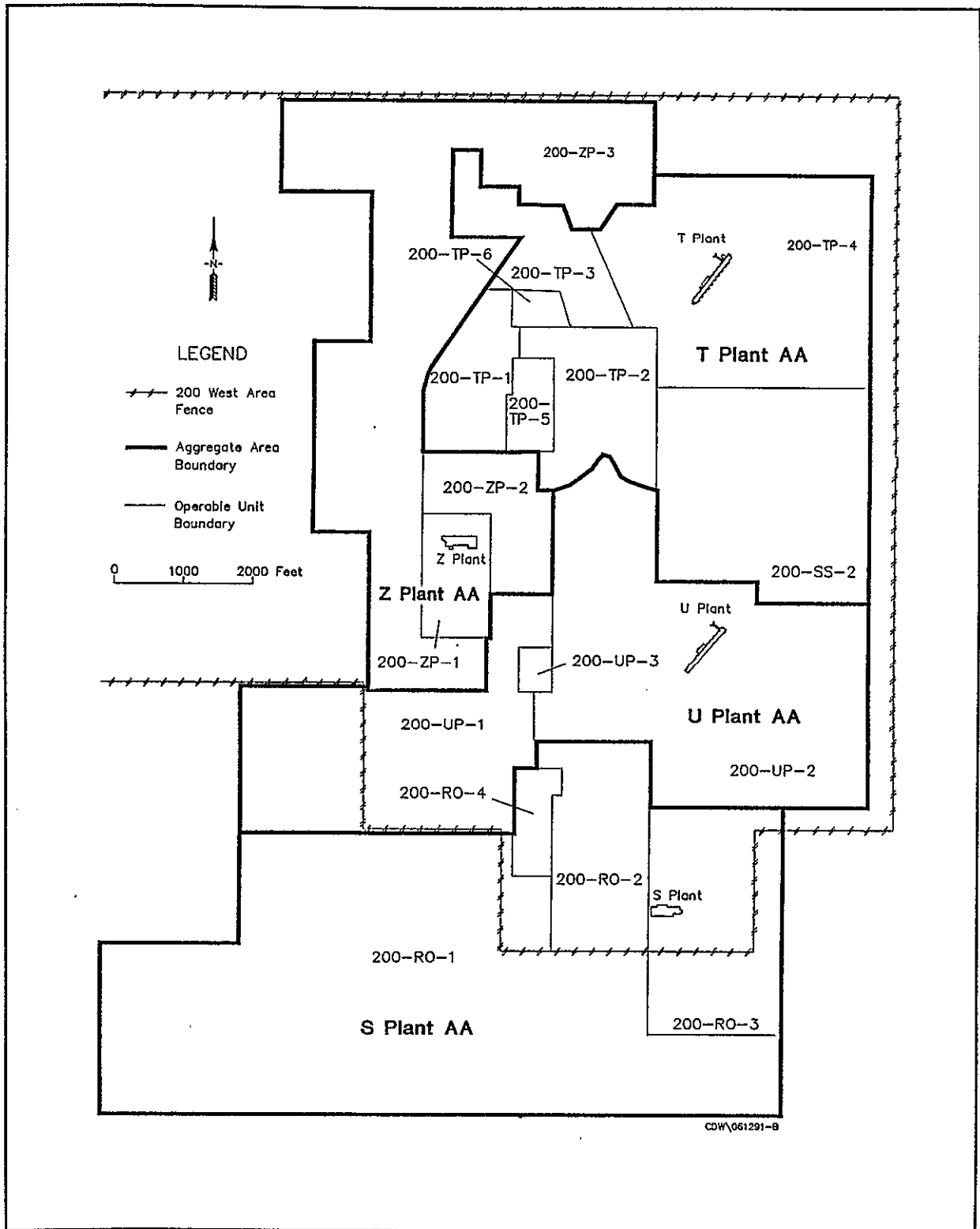


Figure 1-4. 200 West Aggregate Areas.



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Table 1-1. Overall Aggregate Area Management Study (AAMS) Schedule for the 200 NPL Site.

AAMS Title	Operable Units	AAMS Type	Lead Regulatory Agency	M-27-00 Interim Milestones
U Plant	200-UP-1 200-UP-2 200-UP-3	Source	Ecology	M-27-02, January 1992
Z Plant	200-ZP-1 200-ZP-2 200-ZP-3	Source	EPA	M-27-03, February 1992
S Plant	200-RO-1 200-RO-2 200-RO-3 200-RO-4	Source	Ecology	M-27-04, March 1992
T Plant	200-TP-1 200-TP-2 200-TP-3 200-TP-4 200-TP-5 200-TP-6 S00-SS-2	Source	EPA	M-27-05, April 1992
PUREX	200-PO-1 200-PO-2 200-PO-3 200-PO-4 200-PO-5 200-PO-6	Source	Ecology	M-27-06, May 1992
B Plant	200-BP-1 200-BP-2 200-BP-3 200-BP-4 200-BP-5 200-BP-6 200-BP-7 200-BP-8 200-BP-9 200-BP-10 200-BP-11 200-IU-6 200-SS-1	Source	EPA	M-27-07, June 1992
Semi-Works	200-SO-1	Source	Ecology	M-27-08, July 1992
200 North	200-NO-1	Source	EPA	M-27-09, August 1992
200 West	NA	Groundwater	EPA/Ecology	M-27-10, September 1992
200 East	NA	Groundwater	EPA/Ecology	M-27-11, September 1992

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2.0 FACILITY, PROCESS, AND OPERATIONAL HISTORY DESCRIPTIONS

Section 2.0 of this AAMS presents historical data on the Semi-Works Aggregate Area and detailed physical descriptions of the individual waste management units and unplanned releases. These descriptions include historical data on waste sources and disposal practices and are based on a review of current and historical Hanford Site reports, engineering drawings, site inspections, and employee interviews. Section 3.0 describes the environmental setting of the waste management units. The waste types and volumes are qualitatively and quantitatively assessed at each site in Section 4.0. Data from these three sections are used to identify contaminants of concern (Section 4.0), waste management units with a high priority for remediation (Section 5.0), potential ARARs (Section 6.0), and current data gaps (Section 8.0).

This section describes the location of the Semi-Works Aggregate Area (Section 2.1), summarizes the history of operations (Section 2.2), describes the facilities, buildings, and structures of the Semi-Works Aggregate Area (Section 2.3), and describes the Semi-Works Aggregate Area waste generating processes (Section 2.4). Section 2.5 discusses interactions with other aggregate areas or operable units. Sections 2.6 and 2.7 discuss interactions with the RCRA program and other Hanford programs.

2.1 LOCATION

The Hanford Site, operated by DOE, occupies about 1,450 km² (560 mi²) of the southeastern part of Washington State north of the confluence of the Yakima and Columbia Rivers (Figure 1-1). The 200 East Area is a controlled area of approximately 15 km² (5.8 mi²) near the middle of the Hanford Site. The 200 East Area is about 10 km (6 mi) from the Columbia River and 20 km (12 mi) from the nearest Hanford boundary. There are 20 operable units grouped into three aggregate areas in the 200 East Area (Figure 1-3). The Semi-Works Aggregate Area lies in the central portion of the 200 East Area and consists of one operable unit (200-SO-1) comprising the entire aggregate area (Figure 2-1). The Semi-Works Aggregate Area has a rectangular shape and is approximately 5 acres in area. In documentation reviewed for this report, the Semi-Works is sometimes referred to as the Hot Semi-Works, Strontium Semi-Works, 201-C Area, or C Plant (DeFord 1992).

2.2 HISTORY OF OPERATIONS

The Hanford Site, established in 1943, was originally designed, built, and operated to produce plutonium for nuclear weapons using production reactors and chemical reprocessing plants. In March 1943, construction began on three reactor facilities and three chemical processing facilities. After World War II, six more production reactors were built. Beginning in the 1950s, waste management, energy research and development, isotope use, and other activities were added to the Hanford operation. In early 1964, a presidential decision was made to begin shutdown of the reactors. Eight of the reactors were shut down by 1971. The N Reactor operated in weapons grade material production mode to 1987 with secondary steam production for power generating and was placed on cold standby status in October 1989. In September 1991, the decision was made to decommission the last reactor. The N Reactor is scheduled to be completely shutdown in 1999.

Operations in the 200 Areas (West and East) are mainly related to spent nuclear fuel separation. Spent nuclear fuel is fuel that has been withdrawn from a nuclear reactor following irradiation. The 200 East Area consists of three main former processing areas (Figure 1-3):

- 221-B Building (B Plant), where bismuth phosphate processes separated plutonium from spent uranium fuel rods
- 202-A Building (PUREX Plant), where a tributylphosphate extraction process separated plutonium from spent uranium fuel rods
- 201-C Process Building (Semi-Works Complex), where plutonium separation technology was developed (decommissioned)

The 200 Areas also contain nonradioactive support facilities, including transportation maintenance buildings, service stations, coal-fired powerhouses for process steam production, steam transmission lines, raw water treatment plants, water-storage tanks, electrical maintenance facilities, and subsurface sewage disposal systems (DOE/RL 1988).

The Semi-Works Aggregate Area was composed of two primary facilities; the 201-C Process Building and the Critical Mass Laboratory (209-E Building). The 201-C Process Building was constructed in 1949 as a pilot plant for reprocessing reactor fuel. In 1961 it was again converted to recover strontium from fission product waste. This facility operated until 1967. Decommissioning of the facility began in 1983 (DeFord 1992).

1 The Critical Mass Laboratory (209-E Building) was operated from 1960 to 1987 by
2 PNL. Criticality experiments and research were conducted at this location. Currently the
3 laboratory is closed, and the facility has been transferred to WHC for use by Waste Tank
4 Management (DeFord 1992).

7 2.3 FACILITIES, BUILDINGS, AND STRUCTURES

9 The Semi-Works Aggregate Area contains a variety of waste disposal and storage
10 facilities that were associated with the aggregate area. High-level wastes were stored in
11 underground tanks. Low-level wastes such as cooling and condensate water were allowed
12 to infiltrate into the ground through ponds and cribs. These waste types are defined in
13 DOE Order 5820.2A:

- 15 • High-Level Waste is defined as: highly radioactive waste material that
16 results from the reprocessing of spent nuclear fuel, including liquid waste
17 produced directly in reprocessing and any solid waste derived from the
18 liquid, that contains a combination of transuranic waste and fission products
19 in concentrations as to require permanent isolation.
- 21 • Transuranic Waste is defined as: without regard to source or form, waste
22 that is contaminated with alpha-emitting transuranium radionuclides with
23 half-lives greater than 20 years and concentrations greater than 100 nCi/g
24 at the time of assay. Heads of Field Elements can determine that other
25 alpha-contaminated wastes, peculiar to a specific site, must be managed as
26 transuranic waste.
- 28 • Low-Level Waste is defined as: waste that contains radioactivity and is not
29 classified as high-level waste, transuranic waste, or spent nuclear fuel, of
30 11e(2) byproduct material as defined by this Order. Test specimens of
31 fissionable material irradiated for research and development only, and not
32 for the production of power or plutonium, may be classified as low-level
33 waste, provided the concentration of transuranic is less than 100 nCi/g.
- 35 • Byproduct Material is defined as: a) Any radioactive material (except
36 special nuclear material) yielded in, or made radioactive by, exposure to
37 the radiation incident or to the process of producing or utilizing special
38 nuclear material. For purposes of determining the applicability of the
39 RCRA to any radioactive waste, the term "any radioactive material" refers
40 only to the actual radionuclides dispersed or suspended in the waste
41 substance. The nonradioactive hazardous waste component of the waste
42 substance will be subject to regulation under the RCRA. b) The tailings or

waste produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content. Ore bodies depleted by uranium solution extraction operations and which remain underground do not constitute "byproduct material."

Based on construction, purpose, or origin, the Semi-Works Aggregate Area waste management units fall into one of ten subgroups as follows:

- Plants, Buildings, and Storage Areas (Section 2.3.1)
- Tanks and Vaults (Section 2.3.2)
- Cribs and Drains (Section 2.3.3)
- Reverse Wells (Section 2.3.4)
- Ponds, Ditches, and Trenches (Section 2.3.5)
- Septic Tanks and Associated Drain Fields (Section 2.3.6)
- Transfer Facilities, Diversion Boxes, and Pipelines (Sections 2.3.7)
- Basins (Section 2.3.8)
- Burial Sites (Section 2.3.9)
- Unplanned Releases (Section 2.3.10)

Table 2-1 presents a list of the waste management units within the Semi-Works Aggregate Area. In addition, the aggregate area contains several unplanned release sites. The locations of these waste management units are shown on separate figures for each waste management group. Tables 2-2 and 2-3 summarize data available regarding the quantity and types of wastes disposed of to the waste management units. These data have been compiled from WIDS (WHC 1992a) inventory sheets and other sources (Cummings 1988 and 1989, DeFord 1992, and Maxfield 1979) reviewed for this report. The waste inventories reported in Tables 2-2 and 2-3 reflect the materials handled or disposed of at the facilities listed, but not all of these facilities released radionuclide or chemical constituents to the environment. Figures 2-1 through 2-9 show the physical location of the waste management units and unplanned releases. Years of operations for Semi-Works Aggregate Area operating processes and waste management units are shown on Figure 2-10 and Figure 2-11, respectively. Figures 2-12 through 2-14 show representative construction details of individual waste management units.

1 In the following sections each waste management unit is described within the
2 context of one of the aforementioned subgroups. Hanford coordinate information
3 presented in these sections was reported by DeFord (1992) and in WIDS (WHC 1992a).
4

6 **2.3.1 Plants, Buildings, and Storage Areas**

7

8 Plants and buildings are not generally identified as past practice waste
9 management units according to the *Hanford Federal Facility Agreement and Consent Order*
10 (Tri-Party Agreement) and will generally be addressed under the Surplus Facilities
11 Program (see Section 2.7). However, the Semi-Works Aggregate Area is unique among
12 the aggregate areas because of the decommissioning activities initiated in 1983 for the
13 Semi-Works complex which contains the 201-C Process Building along with several
14 support buildings and waste management units. In general, decommissioning efforts
15 involved removal of contaminated equipment and materials, decontamination of
16 radioactive surface contamination, and dismantling of the above-ground portions of some
17 structures and stabilizing underground portions in place by filling voids with grout. Since
18 the entombed portions of the structures may contain radioactive and/or hazardous
19 material contamination, they will be considered as waste management units.
20

21 Section 2.3.1.1 provides an overview of the decommissioning program at Semi-
22 Works Aggregate Area. The primary buildings in this aggregate area, including the
23 Critical Mass Laboratory, are also discussed individually. The locations of former and
24 existing structures are presented on Figure 2-1.
25

26 **2.3.1.1 Decommissioning Activities and Building Descriptions**

27

28 The decommissioning of the semi-works complex included the following structures:

- 30 • 201-C Process Building
- 31
- 32 • 291-C Ventilation System
- 33
- 34 • 276-C Solvent Handling Facility
- 35
- 36 • 2707-C Storage and Change House
- 37
- 38 • 215-C Gas Preparation Building
- 39
- 40 • 271-C Aqueous Makeup and Control Building
- 41

1 In addition, three underground storage tanks were also slated for decommissioning
2 under this program, as discussed in Section 2.3.2.

3
4 The major objective of the Semi-Works decommissioning program was to
5 minimize the potential spread of radioactive materials from the facility (DeFord 1992).
6 The strategy involved decontaminating and dismantling the above-ground portions of the
7 structures and entombing underground portions with concrete grout. Subsequently the
8 entombed facilities were to be covered with an engineered earthen barrier providing a
9 minimum cover of 4.6 m (15 feet) over all contaminated materials and surfaces. This
10 barrier was to consist of a base layer of bottom ash from the 200 East Steam Plant
11 beneath a four-foot thickness of soil and a surface soil stabilizing mat. The side slopes
12 were to be armored and the stable surface areas vegetated.

13
14 The present status of this program is as follows: the 276-C Solvent Handling
15 Facility and the 215-C Gas Preparation Building have been decontaminated for reuse.
16 The 2707-C Storage and Change House and the 271-C Aqueous Makeup & Control
17 Building have been decontaminated and dismantled. Portions of the 201-C Process
18 Building and the 291-C Ventilation System have been dismantled, while other portions
19 have been entombed on site. The initial base layer of bottom ash has been put in place;
20 however, construction of the entire barrier has been delayed due to the need to integrate
21 CERCLA requirements into the decommissioning project (DeFord 1992).

22
23 **2.3.1.1.1 201-C Process Building.** The 201-C Process Building was the main
24 processing facility for the Semi-Works Aggregate Area. During its history the 201-C
25 Process Building went through three distinct operational modes. It was originally built in
26 1949 as a pilot plant for the REDOX process, then was converted to a pilot plant for the
27 PUREX process in 1954. Additional conversions took place in 1961 for recovery of
28 strontium and later for recovery of cerium, technetium, and promethium (Figure 2-10).
29 No information was available in the documents reviewed as to the origin and disposition
30 of the cerium and technetium. The promethium came from the B Plant. The extracted
31 fission products were reportedly shipped to the Oak Ridge National Laboratory.

32
33 The building was located at Hanford coordinates N422000/W50300 and was
34 approximately 42.7 m (140 ft) in length and 24.4 m (80 ft) wide. The building extended
35 approximately 9.1 m (30 ft) above ground and 9.1 m (30 ft) below ground (WHC 1992a).
36 The 201-C Process Building consisted of 3 integrated cells (A, B, and C), seven process
37 galleries, a gallery exhaust system, a hot shop, and an air treatment room. In addition,
38 two cells (D and E) were connected to the east side of the building (DeFord 1992). The
39 date of addition of these cells to the 201-C Process Building was not available in the
40 documents reviewed. The building/cells were largely constructed of concrete. The
41 process equipment in the 201-C Process Building consisted of approximately 38 stainless

1 steel tanks, 19 solvent exchange columns, 13 centrifugal pumps, and a large amount of
2 primarily stainless steel process and service piping (WHC 1992a).

3
4 The 201-C Process Building cell areas were used for materials processing,
5 handling, and storage. Product (plutonium) and high-level waste handling were
6 conducted primarily in A Cell which was equipped with welded process and service lines.
7 Reprocessed reactor fuel, purified plutonium, and recovered strontium, cerium,
8 technetium, and promethium were products obtained during various stages of operations
9 at the 201-C Process Building. The original concrete floor of this cell was contaminated
10 by spilled process solution containing plutonium. The B Cell contained solvent extraction
11 columns and an ion exchange column. C Cell was used for radioactive solvent handling
12 and limited batch rework processing. The D Cell was used for loading strontium product
13 into shipping casks. The E Cell was used as a strontium storage vault and contained four
14 stainless tanks which stored megacurie quantities of strontium. The hot shop and air
15 treatment room were located adjacent to the south wall of B Cell. These rooms served
16 as a maintenance area for contaminated equipment and provided a controlled area for
17 opening the doors into the A, B, and C Cells.

18
19 Decommissioning of the building was initiated in 1983 and completed in 1987.
20 Efforts included decontaminating and dismantling the building by removing piping, small
21 equipment, the outer walls, roof, superstructure, large equipment, and floors from the top
22 down. Contaminated portions of the structure were disposed of in the 218-C-9 Burial
23 Ground located in the Semi-Works Aggregate Area, while uncontaminated portions were
24 taken to the Central Landfill south of the 200 East Area (DeFord 1992). The building
25 was dismantled to 3 m (10 ft) above grade. The remaining portions of the building,
26 including the process cells and equipment, were filled with grout and partially covered
27 over with 3 m (10 ft) of ash, the initial component of a proposed engineered cover
28 (DeFord 1992). Estimated radionuclide and lead shielding inventories for this unit are
29 presented in Table 2-2.

30
31 **2.3.1.1.2 215-C Gas Preparation Building.** The 215-C Gas Preparation Building
32 was constructed for use as a support facility to the 201-C Process Building. The original
33 construction date of the 215-C Gas Preparation Building was not reported in the
34 documents reviewed. It provided compressed air for pneumatic equipment and
35 instruments. It also provided inert gas for use in the 201-C Process Building when
36 flammable solvents were in use.

37
38 The building is located north of the former 201-C Process Building at Hanford
39 coordinates N42500/W50200. The 215-C Gas Preparation Building has two rooms on a
40 single level and dimensions of approximately 10.7 m (35 ft) in length, 6.4 m (21 ft) in
41 width, and 4 m (13 ft) in height. These rooms provided storage for equipment,

compressors, and gas cylinders. There is a lean-to on the south side of the building, which protected three compressed air storage tanks.

The 215-C Gas Preparation Building previously contained radioactively contaminated structures and equipment. As part of decommissioning operations, all equipment was removed from in and around the building. In 1985, the building was decontaminated and is currently used to store miscellaneous equipment (DeFord 1992). It is, however, still within the radiation control area for the complex.

2.3.1.1.3 271-C Aqueous Makeup and Control Building. The 271-C Aqueous Makeup and Control Building was the control center for the 201-C Process Building operations. It included an aqueous makeup area for "cold" (non-radioactive) solutions. This three-story building occupied an area of 295 m² (3,200 ft²) and was constructed of steel frame on a concrete pad with metal siding and a steel deck roof. The building was divided into three separate sections, including a control room for the process cells and different areas for aqueous "cold" solutions (DeFord 1992). The building previously contained 26 tanks, mostly stainless steel, 13 pumps, piping, tubing, and control panels. Waste discharges from this building included process cooling water.

The building was initially decontaminated and subsequently dismantled by removing all piping, equipment, the outer walls, roof, superstructure, and the floors. Contaminated portions of the structure were disposed of in the 218-C-9 Burial Ground. Uncontaminated portions of the building were taken to the Central Landfill. The large tanks were removed for reuse. The building foundation remains at the site, but is partially covered with an ash barrier (DeFord 1992).

2.3.1.1.4 291-C Ventilation System. The 291-C Ventilation System contained air filter and ventilation equipment used to provide exhaust air ventilation for operation cells and process vessel vents from the 201-C Process Building. The building complex is also identified as the 291-C Filter/Fan House. Information describing when the system began operations was not found in the documents reviewed. The 291-C Ventilation System Buildings were located northeast of the 201-C Building at Hanford coordinates N42340/W50050.

The 291-C Ventilation System was composed of the following structures:

- 291-C Fan House
- 291-C Stack
- Fiberglass Filter Building

- HEPA Filter 1
- HEPA Filter 2
- Air Tunnel

The 291-C Fan House and the HEPA Filter 2 were located above ground, while the Fiberglass Filter Building and the HEPA Filter 1 were below grade. The air tunnel connecting the system with the 201-C Process Building was about 61 m (200 ft) long, with the first 30.5 m (100 ft) of the tunnel situated approximately 6 m (20 ft) below grade. The remaining 30.5 m (100 ft) were 1.5 m (5 ft) below grade.

The 291-C Stack was located just west of the 291-C Fan House Building. The unit was a double-shell, reinforced concrete structure lined with brick, approximately 61 m (200 ft) high. It was used to exhaust discharge air from the plant process cells after the air passed through the various filters (Louie and Speer 1989). The stack has been inactive since 1967 and was demolished in 1985.

The radionuclide inventory reported for the ventilation systems was located primarily in the fiberglass filters and HEPA Filter 1 (DeFord 1992). The inside of the stack also contained radiological contamination.

Decommissioning activities included dismantling and removal of the 291-C Fan house and the HEPA Filter 2. The HEPA Filter 1, the Fiberglass Filter Building, and the Air Tunnel were filled with grout and left in place.

The stack was demolished during decommissioning activities. Prior to demolition, the interior surfaces were partially decontaminated using remote-controlled sandblasting. The interior was subsequently painted to stabilize remaining contaminants, and the stack was felled using explosives into a prepared trench running south from the stack base. The stack rubble was further demolished to minimize void spaces and ash was used to fill the voids (DeFord 1992). The stack base was filled with concrete. Subsequently, the entombed portions of the 291-C Ventilation System were covered with the ash barrier.

Estimated radionuclide waste inventories for this unit are presented in Table 2-2. There is no chemical waste inventory data available.

2.3.1.1.5 2707-C Storage and Change House. The 2707-C Storage and Change House was a one-level wood frame structure containing maintenance and instrument shops, and locker rooms with restroom facilities for personnel. The personnel decontamination room contained a shower and sink. The building also contained office

space and a lunch room. Sanitary waste water and shower water from 2707-C Charge House was sent to 2607-E5 Septic Tank and the associated drain field.

During decommissioning activities, the sink and shower in the decontamination room were removed and their common drain grouted. The water and steam lines were isolated, the transite siding removed, and the building and concrete slab were demolished. The site was then backfilled and graded to match existing terrain (DeFord 1992).

2.3.1.1.6 276-C Solvent Handling Facility. The 276-C Solvent Handling Facility contained equipment and tanks for the treatment and storage of process solvents used in the 201-C Process Building operations. The 276-C Solvent Handling Facility is a four-story structure extending approximately 14 m (46 ft) above grade with a total floor area of 213.5 m² (2,300 ft²) (DeFord 1992). The building is steel framed with metal siding, concrete floors, and a concrete roof. All of the exposed steel framework is covered with one inch of heat-resistant plaster. No information regarding the type of solvent treatment was available in the documents reviewed.

Equipment used for solvent treatment was located on the first level. The chemical addition tanks were located on the second level mezzanine. Head tanks and storage tanks for clean solvents were located on the third and fourth levels. Removable panels on the top two levels allowed large equipment to be removed from the building. The head tanks delivered organic feeds by gravity to the 201-C Process Building. In addition, a large heating, ventilation, and air conditioning (HVAC) unit was located on the second level. The power control room was attached to the south side of the building.

In 1984, the facility was partially decommissioned by removing all radioactively contaminated tanks and piping within the building and decontaminating all exposed surfaces. The building was subsequently used for a period of time as an equipment storage area unrelated to Semi-Works, but is now inactive (DeFord 1992).

2.3.1.1.7 Additional Structures Associated with the Semi-Works Complex. Hanford Drawings H-2-44501 and figures in DeFord (1992) indicate other structures are, or were at one time, located in the Semi-Works complex. In the documents reviewed for this study, limited information was available regarding these structures. The location of the structures are presented on Figure 2-1. The following paragraphs present a brief summary of the additional structures.

The 2715-C Storage Building was located along the south side of Seventh Street, approximately 23 m (75 ft) west of the 2704-C Office Building. No other information was found in the documents reviewed regarding its specific use. The building has been removed.

1 The 2704-C Office Building is also located along the south side of Seventh Street,
2 immediately west of the main entrance gate to the 201-C Process Building. The building
3 was the guard house for the Semi-Works Complex and is not currently occupied.
4

5 A Control Building was associated with, and located immediately north of, the
6 241-CX-72 Storage Tank. The building was used as a process control facility for the
7 241-CX-72 Storage Tank. The building was removed as part of the decommissioning of
8 the 241-CX-72 Storage Tank (DeFord 1992).
9

10 The 272-C Building is referred to as a maintenance shop on Westinghouse
11 Hanford drawings. It was located immediately north of the 276-C Solvent Handling
12 Facility and immediately west of the decommissioned 2707-C Storage and Change House.
13 The building has been removed.
14

15 **2.3.1.1.8 Critical Mass Laboratory (209-E Building).** The Critical Mass
16 Laboratory is located west of the 201-C Process Building. The Critical Mass Laboratory
17 is an L-shaped concrete block structure. One wing houses offices, control room shops,
18 and common facilities. The other wing houses an equipment room, change room, mixing
19 laboratory, and a two-story reactor hall. The reactor hall is heavily shielded (DeFord
20 1992).
21

22 Criticality experiments were conducted in the Critical Mass Room from 1960 to
23 1983 using plutonium nitrate and enriched uranium solutions. Criticality research was
24 also conducted with solid special nuclear materials and fuels (DeFord 1992).
25

26 The laboratory is currently closed but not decommissioned. No research has
27 occurred there since 1983. The administrative offices were transferred to WHC in
28 January 1992 and occupied in April 1992, by Westinghouse Hanford Tank Farm Waste
29 Management.
30

31 The 2718 Storage Building is an existing structure located adjacent to the
32 southwest corner of the Critical Mass Laboratory. It serves as a small storage building in
33 which containers of uranyl nitrate were at one time stored. It was the site of the
34 Unplanned Release UN-200-E-141 in 1984. This facility is posted as a radiologically
35 controlled area.
36
37

38 **2.3.2 Tanks and Vaults**

39

40 Tanks and vaults were constructed to handle and store liquid wastes generated by
41 processing operations. Three storage tanks are located within the boundaries of the
42 Semi-Works Aggregate Area at the Hanford Facility; the 241-CX-70, 241-CX-71, and

241-CX-72 Storage Tanks (Figure 2-2). Processes that were associated with and descriptions of these three tanks are provided below.

2.3.2.1 241-CX-70 Storage Tank. The 241-CX-70 Storage Tank was used to store high-level process waste from pilot studies. It is located south of the former 201-C Process Building at Hanford coordinates N42100/W50200. A schematic diagram of the 241-CX-70 Storage Tank is presented on Figure 2-12.

The tank has a 113,500 liter (30,000 gallon) design capacity. It is 4.6 m (15 ft) deep, 6.1 m (20 ft) in diameter, and is buried approximately 3.4 m (11 ft) below grade. It is constructed of 0.6 cm (0.25 in) stainless steel plate inside of a poured concrete covering. The concrete thickness on the tank top and sides is 0.3 m (1 ft), while the bottom thickness varies from 0.25 to 0.6 m (0.8 to 2 ft). Two fill pipes enter the side of the tank near its top, and nine riser pipes extend out of the tank to above grade (Deford 1992).

In 1979 the tank was partially pumped out by an overground transfer to the CR vault and the tank farms, leaving approximately 38,986 liters (10,300 gallons) of sludge containing $^{239/240}\text{Pu}$, ^{137}Cs , ^{90}Sr , NaNO_3 , NaNO_2 , NaF , $\text{Al}_2(\text{SO}_4)_3$, and Na_2CrO_4 in place.

Removal activities for the remaining waste in the 241-CX-70 Storage Tank were initiated in the summer of 1987 with the construction of a sluicing/pumping system. The sluicing/pumping system involved using large volumes of water to sluice/pump the sludge from the 241-CX-70 Storage Tank to Tank Farms. Sluicing was intended to loosen and suspend the waste sludge in water. Approximately 529,900 liters (140,000 gallons) of water was used to sluice the original waste volume of 38,986 liters (10,300 gallons) down to 2,839 liters (750 gallons). Wastes from the tank were analyzed for classification as a RCRA waste. The waste was classified as a RCRA waste because of corrosivity (D002) based on the presence of sodium hydroxide. The mixed waste was also classified as a RCRA toxicity characteristic waste due to detection of chromium (D007) and as a toxic state-only waste (WT02, dangerous waste). The remaining 2,839 liters (750 gallons) were drummed and transferred to the Hanford Central Waste Complex in May 1992. The site is covered with a temporary plywood structure called a "greenhouse." The estimated radionuclide and chemical waste inventories for this tank are presented in Table 2-2 and 2-3, respectively.

2.3.2.2 241-CX-71 Storage Tank. The 241-CX-71 Storage Tank operated as a flow-through tank to help neutralize the acidic 201-C Process Building condensate, and the coil and condensate cooling water stream before the liquid was discharged to the 216-C-1 Crib. It may have also received process condensates from REDOX, plutonium-uranium extraction (PUREX) pilot plant operations, decontamination flushes following the completion of PUREX pilot plant operations, and Hot Shop sink wastes. The 241-CX-71

1 Storage Tank is located south of the former 201-C Process Building. A schematic
2 diagram of the 241-CX-71 Storage Tank is presented on Figure 2-13. This tank was
3 partially filled with a bed of limestone aggregate to promote neutralization. To renew the
4 limestone bed as it was dissolved by the acid, additional limestone was periodically added
5 through the large central riser pipe. Cummings (1989) and others indicate that there is
6 little reliable historical information concerning this tank.

7
8 The tank has a 3,785 liter (1,000 gallon) design capacity. Available
9 documentation, including the Dangerous Waste Part A Permit Application for the
10 241-CX Tank System (1992) and DeFord (1992) indicate that the 241-CX-71 Storage
11 Tank is a cylindrical, single-shell, stainless steel tank which is approximately 1.5 m (5 ft)
12 in diameter and 2.1 m (6.85 ft) deep, and is buried approximately 1.1 m (3.5 ft) below
13 grade.

14
15 The tank void and risers were filled with grout in 1986 in accordance with the
16 decommissioning plan. The tank was subsequently sampled in the fall of 1990 to
17 determine what chemical constituents were within the tank. The estimated radionuclide
18 inventory for this tank are presented in Table 2-2. No chemical waste inventory was
19 found for this tank.

20
21 **2.3.2.3 241-CX-72 Storage Tank.** The 241-CX-72 Storage Tank began operation in 1957
22 and was used experimentally as a "complex waste self-concentrator" for Semi-Works
23 PUREX pilot plant operations waste (DeFord 1992 and Cummings 1989). Records
24 indicate that this tank was in operation for less than one year. It is located southeast of
25 the former 201-C Process Building at Hanford coordinates N41900/W50100. A schematic
26 diagram of the 241-CX-72 Storage Tank is presented on Figure 2-14.

27
28 The 241-CX-72 Storage Tank is an upright, cylindrical single-shell carbon steel
29 tank, approximately 1.0 m (40 in) in diameter, 11 m (36 ft) deep, and is buried
30 approximately 4.3 m (14 ft) below grade. The tank walls are reinforced with five
31 stiffener rings that extend nearly out to the walls of its caisson enclosure. Three rows of
32 vertical guides connect the stiffener rings. It has a 8,800 liter (2,300 gallon) design
33 capacity and was constructed in association with the 241-CX Vault (discussed at the end
34 of this section) and a sampling pit. An 7.6 cm (3 in) diameter drywell is mounted on the
35 inner wall of the tank. The tank rests inside a 1.8 m (6 ft) diameter carbon steel caisson
36 which has a cylindrical electric heater mounted above each stiffener ring. According to
37 DeFord (1992) four pipes extend above grade and two pipes enter the tank underground
38 via the 241-CX Vault. In addition, a manually operated system of agitator rods originally
39 extended from within the tank to above ground. Cummings (1989) reports this tank was
40 not directly associated with any other cribs or tanks.

1 Although there is no supporting documentation, the 241-CX-72 Storage Tank most
2 likely received high level waste from the operation PUREX pilot plant process. The
3 PUREX pilot plant process used tributylphosphate in a kerosene solvent to extract
4 plutonium and uranium from acidic solutions of irradiated uranium. Nitric acid was used
5 to promote the extraction of plutonium and uranium.

6
7 The tank was grouted in 1986 as part of the decommissioning process.
8 Approximately 4.6 m (15 ft) of the internal system of actuator rods was pulled from the
9 tank by heavy equipment sometime between 1986 and 1988 resulting in contamination to
10 the ash material covering this area and the discovery that the tank still contained waste
11 (Griffin and Ludowise 1989). After discovery of the remaining waste, Griffin and
12 Ludowise (1989) concluded that the contents of the 241-CX-72 Storage Tank can be
13 considered transuranic waste and should be retrieved, and that the retrieval of the waste
14 from the 241-CX-72 Storage Tank is feasible using existing technology and methods. The
15 sampling and decommissioning of the tank will be accomplished in three phases. Initial
16 characterization of the tank and removal of the grout layer will be accomplished in Phase
17 1. During Phase 2, the transuranic sludge in the bottom of the tank will be sampled and
18 analyzed. The process for retrieval of this material will also be designed in Phase 2.
19 During Phase 3, the transuranic sludge material will be retrieved and the tank will be
20 stabilized for future closure under RCRA. The decommissioning project will require at
21 least 2 years 9 months to complete (Griffin and Ludowise 1989).

22
23 Currently, the sludge in the tank is believed to contain approximately 200 grams of
24 plutonium 239/240 (WHC 1990). Summaries of the estimated radionuclide waste
25 inventories for this tank are presented in Table 2-2.

26
27 The 241-CX-72 Vault is located below grade directly north of the 241-CX-72
28 Storage Tank. The vault is constructed of reinforced concrete and is divided into an
29 instrument section, mechanical section, and a small sample pit. Exterior walls and floor
30 are 0.3 m (1 ft) thick concrete with a 0.75 m (2.5 ft) thick dividing wall. The control
31 building, located north of the tank and vault, has been removed. The vault's floor drain
32 was connected via pipeline to the 216-C-6 Crib. The 241-CX-72 Vault was filled with
33 grout as part of the decommissioning project.

34 35 36 **2.3.3 Cribs and Drains**

37
38 The cribs and drains are designed to percolate wastewater into the ground. Seven
39 cribs were identified as waste management units at the Semi-Works Aggregate Area. In
40 addition, four other drains were identified during the investigation for this AAMS. While
41 not designated as waste management units, they are discussed in this section. The
42 locations of the cribs and drains are shown on Figure 2-3. Cribs are shallow excavations

1 that are either backfilled with permeable material or supported by concrete ties. Liquid
2 wastes were directed into the cribs and drains, where they then percolated into the
3 vadose zone soils beneath the ground surface.
4

5 **2.3.3.1 216-C-1 Crib.** The 216-C-1 Crib began operations in 1953 and was retired in
6 1957. The crib is located 76 m (250 ft) south of the 2704-C Building at Hanford
7 coordinates N42069/W50235 (WHC 1992a). This crib is constructed with concrete ties,
8 spacer blocks, and roof slab, and measures 7 m (23 ft) long, 1.7 m (5.5 ft) wide, and
9 2.4 m (8 ft) wide. Sources reviewed for this report indicate that the crib was set in an
10 excavation 4 to 5.2 m (13 to 17 ft) deep, and was covered with a layer of gravel and then
11 soil. Until it was stabilized in the mid-1980s, the crib location was marked by a 1.5 m (5
12 ft) depression in the ground surface. Per Maxfield (1979), this crib and the 216-C-3,
13 216-C-4, and 216-C-5 Cribs were stabilized by 1) blading off 10 cm (4 in.) of ground and
14 placing the soil in the 216-C-1 Crib depression, 2) covering the ground with a 10 cm (4
15 in.) sand pad, 3) applying a herbicide, 4) installing a 10 mil plastic sheet over the entire
16 surface, 5) placing a 30 cm (12 in.) sand pad over the plastic, and 6) stabilizing the area
17 with 10 cm (4 in.) of pit run gravel.
18

19 Two pipes protrude from the roof of the structure to a height of approximately
20 0.9 m (3 ft) above grade. A 20 cm (8 in.) diameter steel well casing extends vertically
21 through the center of the crib from 1.2 m (4 ft) above the structure to 7.6 m (25 ft)
22 below the structure (WHC 1992a). The bottom 1.5 m (5 ft) of the casing are perforated.
23 A 1 cm (0.5 in) steel water level indicator pipe extends down approximately 0.9 m (3 ft)
24 below the crib's roof (DeFord 1992).
25

26 The 216-C-1 Crib received 23,400,000 liters (6,180,000 gallons) of liquid waste.
27 Up until September 1955, the crib received REDOX and PUREX high salt waste,
28 process condensate from the 201-C Process Building, and material described as "cold-run"
29 waste from the REDOX and PUREX Processes by DeFord (1992). From September
30 1955 to June 1957, the crib also received the high salt cold-run waste from the 201-C
31 Process Building (WHC 1992a and Cummings 1989). A summary of the radionuclide and
32 chemical waste inventories for the 216-C-1 Crib are presented in Tables 2-2 and 2-3,
33 respectively. The WIDS (WHC 1992a) estimated there is approximately 153 m³ (200 yd³)
34 of contaminated soil at this site.
35

36 When the site was retired in June of 1957, it was stabilized by blocking off the
37 effluent piping and filling in the depression above the crib with layers of sand and gravel
38 on either side of 10 mil plastic sheeting.
39

40 **2.3.3.2 216-C-3 Crib.** This drain field-type crib received waste during 1953 and 1954.
41 The crib is located 122 m (400 ft) south of 7th Street and 114 m (375 ft) south/southwest
42 of the 2704-C Building, at Hanford coordinates N42055/W50390. It consists of 10 cm (4

1 in) open jointed drain tiles placed in a 41 cm (16 in) gravel bed at the bottom of a 15 m
2 (50 ft) long, 3 m (10 ft) wide, and 3 m (10 ft) deep excavation. The excavation was only
3 partially backfilled during use and completely backfilled when deactivated (DeFord
4 1992). The boundaries of this site are not delineated with a barrier, although the crib is
5 marked by one concrete marker post.

6
7 The 216-C-3 Crib received 5,000,000 liters (1,320,000 gallons) of liquid acidic
8 REDOX Process waste during its period of operation from the 201-C Process, 215-C Gas
9 Preparation, and 271-C Aqueous Makeup and Control Buildings. This waste
10 management unit was also known as the 201-C Leach Pit. A summary of the
11 radionuclide and chemical waste inventories for the 216-C-3 Crib are presented in Tables
12 2-2 and 2-3, respectively (WHC 1992a). There is an estimated 31 m³ (40 yds³) of
13 contaminated soil at this site.

14
15 The site was deactivated by blanking off the pipeline to the crib and backfilling
16 the excavation with layers of sand and gravel on either side of 10 mil plastic sheeting.
17 Currently a gravel road runs across part of this crib site.

18
19 **2.3.3.3 216-C-4 Crib.** The 216-C-4 Crib is a liquid waste drain field-type crib which was
20 used from July 1955 until May 1965. It is situated just west of the 216-C-3 Crib and is
21 approximately 115 m (375 ft) southwest of the 2704-C Building between the two security
22 fences at Hanford coordinates N42060/W50430. The crib is 3 m (10 ft) by 6 m (20 ft),
23 with piping arranged in an H pattern in plan view. It consists of two 6 m (20 ft) lengths
24 of 15 cm (6 in.) diameter galvanized, corrugated, perforated steel pipe connected in the
25 middle with a 2 m (6 ft) length of pipe. The piping system was buried approximately 3
26 m (10 ft) below grade in a bed of gravel, which was covered with tar paper. The
27 excavation was backfilled with gravel (DeFord 1992).

28
29 The 216-C-4 Crib received 170,000 liters (45,000 gallons) of radioactive-
30 contaminated organic waste from the 276-C Solvent Handling Facility. This liquid waste
31 was characterized as low salt and neutral/basic from the PUREX process and the
32 strontium, promethium, cerium, and technetium recovery process. Radionuclide and
33 chemical inventories of the waste are presented in Table 2-2 and 2-3, respectively (WHC
34 1992a and DeFord 1992). The WIDS (WHC 1992a) estimated that there is 93 m³ (112
35 yds³) of contaminated soil present at this site.

36
37 The site was deactivated by valving out the effluent pipeline and covering the crib
38 area with successive layers of sand, 10 mil plastic sheeting, sand, and gravel. Currently
39 two 7.6 cm (3 in) metal pipes extend above grade from this crib area (DeFord 1992).

40
41 **2.3.3.4 216-C-5 Crib.** The 216-C-5 Crib is a liquid waste drain field-type crib which
42 operated from March to June 1955. It is located 114 m (375 ft) south-southwest of the

2704-C Building and 137 m (450 ft) south of 7th Street, at Hanford coordinates N42030/W50360. This crib was constructed with 15 cm (6 in) diameter galvanized, corrugated, perforated steel pipe with the same dimensions and H-pattern (plan view) as the 216-C-4 Crib (3 m [10 ft] long by 6.1 m [20 ft] wide by 4.9 m [16 ft] deep). It is situated approximately 3 m (10 ft) below grade in a bed of gravel, covered with two layers of tar paper and backfill material (WHC 1992a and DeFord 1992).

During its short operational period, the 216-C-5 Crib received 37,900 liters (10,000 gallons) of PUREX high salt and cold-run waste from the 201-C Process Building. High salt wastes were high in sodium content and cold-run wastes were saline solutions left over from testing system integrity. Radionuclide and chemical waste inventories for this crib are presented in Table 2-2 and 2-3, respectively (WHC 1992a and DeFord 1992). The contaminated soil volume of this crib is estimated to be 86 m³ (112 yds³).

The site was deactivated by valving out the effluent pipeline and covering the crib area with successive layers of sand, 10 mil plastic sheeting, sand, and gravel (WHC 1992a and DeFord 1992). On April 1, 1992, the 216-C-5 Crib was backfilled with ash and the posting was downgraded to Underground Radioactive Material.

2.3.3.5 216-C-6 Crib. The 216-C-6 Crib is a liquid waste drain field-type crib which operated from September 1955 to September 1964. It is located 137 m (450 ft) south of 7th Street, at Hanford coordinates N42015/W50066. This crib was constructed with 15 cm (6 in) diameter galvanized, corrugated, perforated 6.1 m (20 ft) length steel pipe with the same dimensions and H-form as the 216-C-4 and 216-C-5 Cribs. It is situated approximately 3 m (10 ft) below grade in a bed of gravel, covered with two layers of tar paper and backfill material. The site dimensions are 6.1 m (20 ft) long by 6.1 m (20 ft) wide by 4.9 m (16 ft) deep (WHC 1992a and DeFord 1992).

The 216-C-6 Crib received 530,000 liters (140,000 gallons) of PUREX, REDOX, and strontium recovery process condensate from the 201-C Process Building and the 241-CX Vault floor drain. The waste is acidic. Radioactive process condensate wastes derived from REDOX and PUREX operation contained cesium-137, ruthenium-106, strontium-90, plutonium-239, and uranium based on WIDS information. Non-radioactive constituents in PUREX process condensates included dilute nitric acid and other inorganic constituents. Radionuclide and chemical waste inventories for this crib are presented in Table 2-2 and 2-3, respectively (WHC 1992a and DeFord 1992). The WIDS (WHC 1992a) estimates the contaminated soil volume at this site as 86 m³ (112 yd³).

The site was deactivated by sealing the effluent pipelines. Currently, four metal vents with vent covers extend approximately 1 m (3 ft) above grade (WHC 1992a and DeFord 1992).

1 **2.3.3.6 216-C-7 Crib.** The 216-C-7 Crib is an inactive liquid waste site. It is a drain
2 field-type crib constructed in 1961 about the same time as the Critical Mass Laboratory,
3 to receive waste streams from the laboratory. It received waste through 1987 but is now
4 inactive. The unit is located approximately 15.2 m (50 ft) southwest of the Critical Mass
5 Laboratory, at Hanford coordinates N42000/W50672.

6
7 The crib was constructed in an H-pattern (plan view) with two 6.1 m (20 ft)
8 lengths of 15 cm (6 in) diameter vitrified clay pipe and one 4.6 m (15 ft) connecting cross
9 pipe. It is buried approximately 3.7 m (12 ft) below grade in a bed of gravel. The gravel
10 bed is separated from backfill material by 6 mil polyethylene sheeting (DeFord 1992).
11 The site dimensions are 6.1 m (20 ft) long by 6.1 m (20 ft) wide by 3.7 m (12 ft) deep
12 (WHC 1992a).

13
14 During its period of operation, the 216-C-7 Crib received 60,000 liters (16,000
15 gallons) of Critical Mass Laboratory liquid waste. Nielsen (1990) described the waste as
16 reflector tank water from two tanks located in the laboratory. Radionuclide and
17 chemical waste inventories for this crib are presented in Table 2-2 and 2-3, respectively
18 (WHC 1992a and DeFord 1992). The WIDS (WHC 1992a) estimated the contaminated
19 soil volume at this site to be 130 m³ (170 yds³).

20
21 Currently, four vitrified clay vent pipes extend approximately 1 m (3 ft) above the
22 ground at the site. DeFord (1992) indicates that these vent pipes extend upward from
23 the four tips of the H-configuration.

24
25 **2.3.3.7 216-C-10 Crib.** The 216-C-10 Crib is an inactive drain field-type crib which
26 received waste from the 201-C Process Building from 1964 to 1967. The crib is located
27 southeast of the 201-C Process Building at Hanford coordinates N42100/W49870. The
28 216-C-10 Crib is constructed of a single 9.8 m (32 ft) length of perforated 7.5 cm (3 in)
29 diameter stainless steel pipe placed in a 1 m (3 ft) deep gravel bed at the bottom of a 2
30 m (7 ft) deep excavation. A 30.5 cm (12 in.) diameter vitrified clay pipe vent extends
31 from the end of the distribution pipe to approximately 1.5 m (5 ft) above grade. A 20
32 cm (8 in.) vitrified clay pipe gage well extends from the bottom of the crib to about 1 m
33 (3 ft) above grade (WHC 1992a and DeFord 1992). The site dimensions are 9.8 m (32
34 ft) long by 1.5 m (5 ft) wide by 2.1 m (7 ft) deep.

35
36 The 216-C-10 Crib received 897,000 liters (237,000 gallons) of acidic process
37 condensate from the strontium recovery process at the 201-C Process Building.
38 Radionuclide and chemical inventories of the waste are presented in Table 2-2 and 2-3,
39 respectively (WHC 1992a and DeFord 1992). The contaminated soil volume at this site
40 is estimated by WIDS (WHC 1992a) to be 66 m³ (86 yds³).

1 **2.3.3.8 Newly Identified Drains.** During the preparation of the Semi-Works AAMS, four
2 additional drains were identified in the Semi-Works Aggregate Area. In general, the
3 information found for these sites was limited, and the sites have not been officially
4 documented, listed as formal waste management units, nor included under the Tri-Party
5 Agreement. More information will be compiled on these drains in the future to assess
6 their historical use and any environmental impact. A formal evaluation of the regulatory
7 status of these drains will be made in accordance with WHC-CM-7, EII 1-10 (WHC
8 1988e). Based on results of this evaluation, the drains may be submitted for listing as
9 official waste management units. The identified drains are described below.

10
11 **2.3.3.8.1 Critical Mass Laboratory Dry Well North.** Site inspection shows a 1.2 m
12 (4 ft) dry well approximately 7.6 m (25 ft) north of the Critical Mass Laboratory. No
13 other information was available on this dry well.

14
15 **2.3.3.8.2 Critical Mass Laboratory Dry Well South.** Site inspection shows a 1.2 m
16 (4 ft) dry well located approximately 7.6 m (25 ft) southeast of the Critical Mass
17 Laboratory. No other information was available on this dry well.

18
19 **2.3.3.8.3 Critical Mass Laboratory Dry Well East.** Site inspection shows a dry
20 well located approximately 7.6 m (25 ft) northeast of the office wing in the Critical Mass
21 Laboratory. No other information was available on this dry well.

22
23 **2.3.3.8.4 Gatehouse French Drain.** Site inspection shows a french drain located
24 approximately 3 m (10 ft) southwest of the 2704-C Building. The drain cover is currently
25 painted yellow and marked with a trifoil (indicating radioactivity is present). No other
26 information was available on this drain.

27
28
29 **2.3.4 Reverse Wells**

30
31 Reverse wells are drilled, encased holes with the lower end of the casing
32 perforated or open to allow liquid to seep into the vadose zone at a depth greater than
33 that for cribs and drains. The location of the 216-C-2 Reverse Well identified at the
34 Semi-Works Aggregate Area is shown on Figure 2-4.

35
36 **2.3.4.1 216-C-2 Reverse Well.** The 216-C-2 Reverse Well is an Ecology-registered
37 underground injection well which received waste from 1953 to 1988 (WHC 1992a). The
38 waste management unit is located approximately 30 m (100 ft) southeast of the former
39 291-C Stack at Hanford coordinates N42300/W50000 and received condensate and seal
40 water effluent from the stack. The well was constructed of 30.5 cm (12 in.) diameter
41 steel pipe which extended approximately 0.3 m (1 ft) above grade and 12.2 m (40 ft)
42 below grade. The lower 7.6 m (25 ft) of the pipe is perforated (DeFord 1992).

1 Condensate from the 291-C Stack drained into the 216-C-2 Reverse Well through
2 a 10 cm (4 in.) diameter pipe which entered the reverse well at about 3 m (10 ft) below
3 grade. The reverse well also received seal water drainage from the stack ventilation filter
4 through a 5 cm (2 in.) diameter line. The liquid waste is characterized as low salt and
5 neutral/basic. The volume of waste received by this reverse well is unknown (WHC
6 1992a and DeFord 1992).

7
8 The unit was decommissioned in 1988 by cutting and capping the two influent
9 lines, isolating it, sealing the wellhead in concrete, and covering it with a 0.9 m (3 ft) ash
10 "barrier" (DeFord 1992).

11 12 13 **2.3.5 Ponds, Ditches, and Trenches**

14
15 The ponds, ditches, and trenches in the Semi-Works Aggregate Area were used to
16 percolate waste liquid into the ground. Ditches and ponds were designed to convey and
17 receive process cooling water. Trenches were excavations that were generally opened for
18 discrete time intervals to facilitate subsurface disposal of liquid waste, then backfilled. At
19 the Semi-Works Aggregate Area one pond and one ditch used for waste disposal were
20 identified from the sources reviewed for this report. Their locations are shown on Figure
21 2-5.

22
23 **2.3.5.1 216-C-9 Pond.** The 216-C-9 Pond is the foundation excavation for the planned
24 221-C Canyon Building which was never completed. The pond began operation in 1953
25 as a receiving site for process cooling water from Semi-Works facilities and operated
26 until 1985. The pond was situated north of 7th Street and was approximately 7,432 m²
27 (80,000 ft²) in area, with dimensions of 244 m (800 ft) in length, 30.5 m (100 ft) in width,
28 and 7.6 m (25 ft) in depth (DeFord 1992). The pond was divided by berms into several
29 lobes. Wastewater was fed to the pond via several diversion boxes and six pipes from
30 facilities in the Semi-Works Aggregate Area. These include the 201-C Process Building,
31 the 215-C Gas Preparation Building, the 291-C Ventilation System, the 2707-C Storage
32 and Change House, and the Critical Mass Laboratory (209-E Building). Liquid waste
33 from the Semi-Works Complex appears to have been directed to the eastern end of the
34 pond while liquid waste from the Critical Mass Laboratory appears to have been directed
35 to the west lobe.

36
37 The 216-C-9 Pond received a total waste volume of 1,030,000,000 liters
38 (272,000,000 gallons). The waste receiving history is as follows:

- 39
40 • Until August 1960, the site received process cooling water from the 201-C
41 Process Building and the other Hot Semi-Works facilities.
42

- From August 1960 to October 1969, the site received the effluents mentioned above plus miscellaneous wastewater from the Critical Mass Laboratory.
- From October 1969 to December 1985, the pond received miscellaneous wastewater from the 201-C Process Building and the Critical Mass Laboratory.

During its operational history, the 216-C-9 Pond received liquids with cesium, ruthenium, strontium, plutonium, and alpha and beta contamination. No radioactivity was found along the pond perimeter in a survey performed on June 22, 1978. Radionuclide and chemical waste inventories for this unit are presented in Table 2-2 and 2-3, respectively (WHC 1992a and DeFord 1992). The volume of contaminated soil is estimated in WIDS (WHC 1992a) to be 2,609 m³ (3,400 yds³).

After the 216-C-9 Pond was shut down in 1985, it dried up and was eventually backfilled with 0.9 m (3 ft) of gravel. Since then the eastern portion of the former pond has been converted into the 218-C-9 Burial Ground and subsequently backfilled to grade with ash.

2.3.5.2 200 East Powerhouse Ditch. The 200 East Powerhouse Ditch runs along the southern boundary of the Semi-Works Aggregate Area. This active ditch drains non-radioactive wastewater from the active 284-E Power Plant located about 1.6 km (1 mile) southwest of the Semi-Works Aggregate Area. DeFord (1992) reports the 200 East Powerhouse Ditch is approximately 762 m (2,500 ft) in length, has a 6.1 m (20 ft) bottom width, and is 3 m (10 ft) deep. The ditch flows to the west into a 76 cm (30 in) diameter corrugated metal pipe that carries water to the 216-B-3 Pond Complex in the B Plant Aggregate Area.

DeFord (1992) reports that the process associated with the 284-E Power Plant is steam production. Purified water from the 283-E Water Treatment facility is heated in coal-fired boilers to produce steam. During this process, three major discharges of waste water occur to the 200 East Powerhouse Ditch:

- The largest discharge is associated with purified water used to cool various components of the 284-E Power Plant and averages a flow rate of about 12,300,000 liters (3,250,000 gallons) per month.
- The second flow of wastewater—the waste brine solution used to regenerate the zeolite water softener columns in the plant—contains the most concentrated single discharge in terms of dissolved solids. This water

contains about 9 percent by weight sodium chloride and has an average monthly flow rate of 1,135,000 liters (300,000 gallons).

- The third discharge comes from the blowdown of scale from inside the boilers. This flow is about 378,000 liters (100,000 gallons) per month. This discharge contains dissolved boiler scale and residual oxygen scavenging chemicals.

2.3.6 Septic Tanks and Associated Drain Fields

Septic tanks and associated drain fields accept sanitary sewer effluent from the buildings in the Semi-Works Aggregate Area. The location of the two septic tank drainfield systems associated with the Semi-Works Aggregate Area are shown on Figure 2-6. Both systems are included in the Tri-Party Agreement (DeFord 1992).

2.3.6.1 2607-E-5 Septic Tank and Drain Field. The 2607-E-5 Septic Tank and associated drain field is an active waste site for sanitary wastes from the Critical Mass Laboratory and mobile offices. This septic tank also received sanitary wastewater from the 2707-C Storage and Change House. The septic system is located north of the 209-E Building and south of 7th Street at Hanford coordinates N42400/W50850. Although WIDS (WHC 1991a) reports the system was constructed in 1944, DeFord (1992) suggests a more likely construction date of 1949 when the Semi-Works Plant was built.

The 2607-E-5 Septic Tank is a 6.4 m (21 ft) long, 2.7 m (9 ft) wide, and 3.7 m (12 ft) deep reinforced concrete structure with a metal manhole cover. The design capacity was 292 persons (132 liters/day [35 gallons/day]) with a 24-hour detention time. The original drain field is located southwest of the tank and was constructed of 10 cm (4 in) diameter pipe (WHC 1992a). According to DeFord (1992), the original drain field was disconnected and abandoned around 1963, and the 2607-E-5 Septic Tank was connected in tandem with the 2607-E-7A Septic Tank and Drain Field.

There are no radioactive or hazardous wastes reported for the 2607-E-5 Septic Tank and drain field in the documents reviewed.

2.3.6.2 2607-E-7A Septic Tank and Drain Field. The 2607-E-7A Septic Tank and associated drain field is an active, sanitary waste site constructed in 1983. The unit is located immediately west of, and is operated in conjunction with, the 2607-E-5 Septic Tank at Hanford coordinates N42400/W51199. The 2607-E-7A Septic Tank consists of two 3.7 m (12 ft) long, 1.5 m (5 ft) wide, and 1.5 m (5 ft) deep concrete tanks connected in tandem. The associated drain field is located west of the tanks.

1 There are no radioactive or hazardous wastes reported for the 2607-E-7A Septic
2 Tank and drain field in the documents reviewed.

3 4 5 **2.3.7 Transfer Facilities, Diversion Boxes, and Pipelines**

6
7 Transfer facilities (also referred to as process lines) interconnect the major
8 processing facilities and the various waste disposal and storage facilities. Most lines are
9 7.6 cm (3 in.) diameter stainless steel pipes with welded joints. Process lines are
10 generally enclosed in steel reinforced concrete encasements and are set below grade.
11 The process lines are not waste management units according to the Tri-Party Agreement
12 and will be addressed in detail under separate programs (e.g., Surplus Facilities
13 Program). However, because of their age and construction, there is a possibility of
14 leakage for some of the process lines along their rights-of-way.

15
16 Pipelines connecting the liquid waste stream generating facilities to their soil
17 column disposal sites (e.g., cribs, ditches) are sometimes constructed of sectional vitreous
18 clay or corrugated metal pipes; these types of lines are expected to have leaked to some
19 degree. The pipeline rights-of-way, therefore, may be contaminated to levels comparable
20 to the soil column sites and may require characterization as part of the soil column
21 disposal facility's investigation.

22
23 Process transfer lines cross the Semi-Works Aggregate Area both north and south
24 of Semi-Works connecting facilities within the PUREX and B Plant Aggregate Areas.
25 There are also steam lines, raw and sanitary water lines, and electrical lines crossing and
26 connected to Semi-Works and the Critical Mass Laboratory facilities.

27
28 Diversion boxes house the switching facilities where waste can be routed from one
29 process line to another. They are concrete boxes that were designed to contain any
30 waste that leaks from the waste transfer line connections. The diversion boxes generally
31 drain by gravity to nearby catch tanks where any spilled waste is stored.

32
33 **2.3.7.1 Semi-Works Valve Pit.** The Semi-Works Valve Pit is also identified as the Hot
34 Semi-Works Valve Pit (WHC 1992a). The unit is a cylindrical stainless steel pit, with a
35 1.7 m (5.5 ft) inside diameter. It is placed below grade and is located adjacent to the
36 east wall of the 201-C Process Building at Hanford coordinates N43220/W51760. The
37 valve pit connected lines from sources within the 201-C Process Building to discharge
38 locations at the 244-CR Vault in the PUREX Aggregate Area, the 241-C Tank Farm,
39 and the 241-CX-70 Storage Tank.

40
41 DeFord (1992) reports the pit was decommissioned in the late 1980s as part of the
42 general Semi-Works decommissioning effort. The lines were sealed, isolated, and the box

1 was filled with concrete. Currently, the site is buried beneath the ash barrier which was
2 placed over the decommissioned 201-C Process Building.
3

4 **2.3.7.2 Critical Mass Laboratory Valve Pit.** The Critical Mass Laboratory Valve Pit is a
5 concrete structure that abuts the south wall of the 209-E Building. It is approximately
6 1.8 m (6 ft) by 2.4 m (8 ft) and stands about 1 m (3 ft) above grade. It has a steel lid
7 and is posted with 'Radioactive Contamination' warning signs.
8

9 DeFord (1992) suggests that the line running to the 216-C-7 Crib originates in this
10 pit. The ventilation stack and fan assembly for the Critical Mass Laboratory are also
11 located at this point. Reportedly radioactive contamination is associated with the valve
12 pit sump, although no specific waste inventories for this unit were found in the
13 documents reviewed. The valve pit and ventilation hardware were integral to the Critical
14 Mass Laboratory and until recently were considered active.
15

16 **2.3.7.3 241-C-154 Diversion Box.** The 241-C-154 Diversion Box operated until 1967 in
17 support of the promethium recovery phase of the Semi-Works operations. The unit is a
18 2.4 m (8 ft) cube, steel reinforced concrete diversion box located about 9.1 m (30 ft)
19 southeast of the southeast corner of the 201-C Process Building at Hanford coordinates
20 N42175/W50140. The unit was associated with a promethium transfer line which
21 connected promethium lines from B Plant to various Semi-Works locations. A floor
22 drain was connected from this diversion box into the Semi-Works Valve Pit (DeFord
23 1992).
24

25 DeFord (1992) reports that this site was decommissioned in 1985 as part of the
26 general Semi-Works decommissioning effort. The decommissioning effort included
27 isolating the lines, sealing, filling the diversion box with concrete, and covering the area
28 with ash.
29

30 No waste characterization or hazardous material inventory is available on the
31 241-C-154 Diversion Box.
32

33 **2.3.8 Basins**

34 Retention basins are concrete lined settling ponds that receive liquids before they
35 overflow into ditches. There are no basins identified in the Semi-Works Aggregate Area
36 in the document reviewed.
37
38
39
40

2.3.9 Burial Sites

There is one burial site, the 218-C-9 Burial Ground, located in the Semi-Works Aggregate Area. The burial ground generally consists of trenches that received radiologically contaminated building rubble and related material, and then were backfilled. The location of the burial ground is shown on Figure 2-8.

2.3.9.1 218-C-9 Burial Ground. The 218-C-9 Burial Ground, also called Dry Waste No. OC9, is a low-level solid waste burial ground which began receiving wastes in 1985. The WIDS (WHC 1992a) suggests that this is an active site, while DeFord (1992) indicates, and field inspection confirms, the site was filled to grade with an ash "barrier" after the 201-C Process Building was decommissioned. The site is situated north of 7th Street in the eastern portion of the old 216-C-9 Pond area, and covers an area of approximately 16,982 m² (182,800 ft²). The pond had dried up by 1985, and was subsequently stabilized with 1 m (3 ft) of fresh gravel before beginning to receive waste.

According to DeFord (1992), the burial grounds received 2,266 m³ (80,000 ft³) of rubble from the decommissioning of the 201-C Process Building. The radiological inventory for the Burial Ground is reported in WHC (1991c) and is shown in Table 2-2. No chemical inventory was located for this waste unit.

2.3.10 Unplanned Releases

Four unplanned releases were identified as waste management units in the Semi-Works Aggregate Area. In addition, two other unplanned releases were identified during the course of the study. While not designated as waste management units, they will be discussed in this section. Table 2-4 summarizes the known information for each unplanned release and, where applicable, lists the waste management unit to which it is related. Most of the information available for the unplanned releases is derived from the WIDS (WHC 1992a). The locations of the unplanned releases in the Semi-Works Plant Aggregate Area are shown on Figure 2-9. In addition to the unplanned releases, there is considerable surface contamination around the 201-C Process Building site.

2.3.10.1 UN-200-E-36. Unplanned Release UN-200-E-36 occurred in July 1967, along 7th Street (WHC 1992a and DeFord 1992). Two pumps removed from the 201-C Process Building were being transported by truck to another location. While in transit leakage contaminated a 274 m (900 ft) long by 137 m (450 ft) wide area along 7th Street. The materials involved in the spill were not reported in the WIDS (WHC 1992a).

1 Beta/gamma readings of 30,000 to 80,000 ct/min were measured at the time of the
2 release. Immediate cleanup activities included flushing the roadway with water. The
3 roadway has been removed from surface contamination status.
4

5 **2.3.10.2 UN-200-E-37.** Unplanned Release UN-200-E-37 is associated with the cleanup
6 effort conducted for Unplanned Release UN-200-E-36. A week after Unplanned
7 Release UN-200-E-36 occurred, contamination was discovered to have spread to a 183 m
8 (600 ft) length of road located east of Semi-Works and to the area south of the road.
9 Presumably this was caused by flushing activities on the section of road originally
10 contaminated. Beta/gamma readings were measured at 200 mrem/hr. The WIDS (WHC
11 1992a) and DeFord (1992) report that sprinklers were set up to flush the contamination
12 below ground. After removal of the contaminated soil, the area was removed from
13 surface contamination status in 1990.
14

15 **2.3.10.3 UN-200-E-98.** Unplanned Release UN-200-E-98 occurred in September 1980 on
16 the east side of the 291-C Stack, near the 216-C-2 Reverse Well. The WIDS (WHC
17 1992a) speculates that particulate matter containing ⁹⁰Sr was inadvertently released to the
18 ground surface. DeFord (1992) reports that although some of the contamination was
19 removed, some residual contamination still remains. The site is currently buried beneath
20 the ash barrier placed over the decommissioned 201-C Process Building.
21

22 **2.3.10.4 UN-200-E-141.** DeFord (1992) reports that Unplanned Release UN-200-E-141
23 occurred in September of 1984 in the 2718 Storage Building located adjacent to the
24 southwest side of the Critical Mass Laboratory. Approximately 208 liters of a 450 gm/L
25 solution of uranyl nitrate (84 percent ²³⁵U) was released onto the concrete floor when
26 one of the storage containers failed due to corrosion (WHC 1992a). All liquids were
27 subsequently removed from the building along with contaminated soil and asphalt. The
28 concrete floor was reportedly decontaminated to background levels.
29

30 **2.3.10.5 Newly Identified Unplanned Releases.** During the course of the Semi-Works
31 AAMS two additional unplanned releases were identified in the Semi-Works Aggregate
32 Area. In general the information found for these unplanned releases was limited, and
33 the sites have not been officially documented, listed as formal waste management units,
34 nor included under the Tri-Party Agreement. More information will be compiled on
35 these unplanned releases in the future to assess their potential impacts to the
36 environment. A formal evaluation of the regulatory status of these sites will be made in
37 accordance with WHC-CM-7, EII 1-10 (WHC 1988e). Based on results of this
38 evaluation, the sites may be submitted for listing as official unplanned releases. The
39 identified unplanned releases are described below.
40

41 **2.3.10.5.1 241-C Waste Line Unplanned Release No. 1.** Immediately east of and
42 abutting the 201-C Process Building in an area called the A Courtyard, is an area of

1 reported underground contamination roughly 39.6 m (130 ft) by 18.3 m (60 ft) identified
2 in 1957. A leak is believed to have originated from a flange in the 241-C Waste Line
3 running from the 201-C Process Building to the 241-C Tank Farm in the PUREX
4 Aggregate Area. Reportedly, the teflon gasket in the flange leaked. Piping was
5 eventually installed to bypass the flanged section of the line. No waste inventory
6 information on this release was available in the documents reviewed. This area is
7 covered with ash.

8
9 **2.3.10.5.2 241-C Waste Line Unplanned Release No. 2.** Approximately 45.7 m
10 (150 ft) east of the 201-C Process Building a second area of underground contamination
11 was identified in 1957. The approximate size of the area is 39.6 m (130 ft) by 9.1 m
12 (30 ft). This release is also believed to have occurred at a flange (with failed teflon
13 gasket) in the 241-C Waste Line. That section of the line was eventually bypassed. No
14 waste inventory information was available for this release.

15 16 17 **2.4 WASTE GENERATING PROCESSES**

18
19 The primary waste generating activities at the Semi-Works Aggregate Area
20 include historical operations in the 201-C Process Building (Semi-Works Complex) and
21 the Critical Mass Laboratory (209-E Building). Other waste-generating facilities include:

- 22
23 • 276-C Solvent Handling Facility
- 24
25 • 291-C Ventilation System Stack
- 26
27 • 215-C Gas Preparation Building
- 28
29 • 271-C Aqueous Makeup and Control Building.

30
31 For the facilities listed, the following subsections describe the waste generating
32 processes, the resulting waste streams, and waste stream disposition and disposal. The
33 discussions incorporate information from reference sources reviewed for this report,
34 including DeFord (1992), Anderson (1990), Nielsen (1990), Cummings (1989), and Evans
35 and Tomlinson (1954). Additional information regarding the nature of waste generating
36 processes and resulting waste streams was not found during document review. Semi-
37 Works waste producing processes and waste stream characteristics are summarized on
38 Table 2-5. Table 2-6 lists chemicals that are known to have been used during processing
39 activities in the Semi-Works Aggregate Area.

2.4.1 201-C Process Building (Semi-Works Complex) REDOX, PUREX, and Strontium Recovery Process Descriptions

The REDOX process was used for the separation of uranium and plutonium from fission products and from each other. The basis of the process was the extraction of uranium and plutonium from an aqueous, high-salt solution in an organic solvent (hexone). This operation was conducted in a continuous, packed solvent extraction column through which the aqueous and organic phases were passed counter-currently. Uranium and plutonium were separated by converting the plutonium to a lower valence state, in which form it was preferentially extracted back into an aqueous phase of high salt content in a second column. Uranium was then returned to an aqueous phase of low salt content in a third column. The products were purified further in similar, additional cycles (Evans and Tomlinson 1954).

The PUREX process used tributylphosphate in kerosene solvent to extract plutonium and uranium from acid solutions of irradiated uranium. Nitric acid was used to promote extraction of plutonium and uranium.

The strontium recovery process was performed utilizing a complexant di-2-ethyl-hexyl phosphoric acid, to extract strontium from acid solutions of waste fuels (Cummings 1989).

2.4.1.1 201-C Process Building Waste Streams and Disposition. Liquid waste streams from the 201-C Process Building consisted of wastes from the pilot REDOX and PUREX recovery activities in the 1950s, and from strontium, cerium, promethium, and technetium recovery in the 1960s. Prior to commencing the actual pilot recovery activities, extensive "cold-run" trials were routinely conducted using nonradioactive materials to verify the operational status of the equipment. The following discussion summarizes the waste streams generated from these processes.

Wastes from the 201-C Process Building were chemically and radiologically contaminated, and their disposition was accomplished in accordance with their radiological content (DeFord 1992).

In general, high-level wastes were stored in underground tanks in the 200 East Area Tank Farms, and low-level wastes were routed to cribs in the Semi-Works Aggregate Area for disposal. Wastes from the 201-C Process Building were sent to several waste management units, including:

- 216-C-9 Pond received low-level process cooling water between 1957 and 1985

- 241-CX-70 and 241-CX-72 Storage Tanks received high-level process wastes between 1952 and 1957
- 241-CX-71 Storage Tank received acidic wastes from 201-C Process Building prior to discharge to the 216-C-1 Crib and unspecified wastes from the 201-C Process Building hot shop sink

2.4.1.1.1 REDOX Process Waste Streams. Wastes generated during the REDOX process included coating wastes from decladding of aluminum fuels in a boiling sodium nitrate/sodium hydroxide solution. The waste stream was composed primarily of uranium, plutonium, sodium hydroxide, sodium aluminate, sodium nitrate and nitrite, and sodium silicate. The waste solution was transferred to a tank separate from the high-level waste. During the REDOX processes, zircaloy-clad fuels were declad in an ammonium nitrate-ammonium fluoride mixture. The REDOX waste stream was composed of large volumes of aluminum nitrate, and zirconium oxide, sodium fluoride, sodium nitrate, potassium fluoride, uranium, and plutonium. Other wastes associated with the REDOX process included chromate, sodium sulfate, and ferric hydroxide compounds in addition to many of the other compounds listed. Waste streams from the REDOX process were slightly acidic and contained fission products including cesium-137, ruthenium-106, strontium-90, plutonium-239, and uranium based on WIDS (WHC 1992a). Cummings (1989) reported the presence of additional radionuclides including tritium, cobalt-60, and uranium-238 in the waste stream. The coating wastes from the aluminum and zircaloy-clad fuels decladding were neutralized with caustic soda.

Wastes generated during the REDOX process were sent to several waste management units, including:

- 216-C-1 Crib received acidic radioactive waste between 1953 and 1954.
- 216-C-3 Crib received acidic radioactive wastes between 1953 and 1954

2.4.1.1.2 PUREX Process Waste Streams. The PUREX process generated wastes from decladding of aluminum and zircaloy fuels which were reportedly identical to those generated from REDOX decladding. During the PUREX process, a potassium permanganate, sodium carbonate, and nitric acid wash were used to separate organic compounds from a process extraction solvent prior to reuse of the solvent. The PUREX organic wash wastes primarily included sodium nitrate, sodium carbonate, manganese oxide, and uranium. Acidic PUREX wastes were neutralized, high level wastes containing nitrate, sulfate, phosphate, sodium, iron, and aluminum. The radionuclides in the waste streams included cesium-137, ruthenium-106, strontium-90, plutonium-239, and uranium (WHC 1992a). Cummings (1989) reported the presence of additional radionuclides including tritium, cobalt-60, and uranium-238 in the waste streams.

1 The process condensate from PUREX was generated as a waste stream. This
2 process condensate consisted of water that had been in intimate contact with process
3 organics, tributyl phosphate, and normal paraffin hydrocarbons. Because these chemicals
4 used were of technical grade, they contained a variety of trace impurities: butanol,
5 butyraldehyde, acetone, methyl ethyl ketone, and others. In addition, degradation
6 products are also expected from the breakdown of unstable compounds, such as tributyl
7 phosphate.

8
9 Wastes generated during the PUREX process were sent to several waste
10 management units, including:

- 11
12 • 241-CX-72 Storage Tank received waste during 1955
- 13
14 • 216-C-1 Crib received neutral to basic process condensate and cold oven
15 wastes between 1954 to 1956
- 16
17 • 216-C-5 Crib received high salt, neutral to basic process condensate in
18 1955.
- 19
20 • 216-C-6 Crib received acidic process condensates between 1955 and 1964
- 21
22 • 216-C-10 Crib received acidic process condensates from 1955 to 1956
- 23

24 **2.4.1.1.3 Strontium Recovery Waste Streams.** Limited information from
25 Cummings (1989) indicates that the strontium recovery process in the 201-C Process
26 Building utilized an organic complexing agent, di-2-ethyl-hexyl phosphoric acid, to extract
27 strontium from acid solutions of waste fuels. No information regarding specific
28 characteristics of wastes derived from cerium, technetium, and promethium recovery
29 were found in the documents reviewed.

30
31 Wastes from the strontium recovery were directed to several waste management
32 units, including:

- 33
34 • 241-CX-72 Storage Tank received wastes with high levels of radioactivity
- 35
36 • 216-C-6 Crib received acidic process condensate wastes between 1961 and
37 1964
- 38
39 • 216-C-10 Crib received acidic process condensate wastes between 1964 and
40 1967.
- 41

1 **2.4.1.1.4 Other Waste Streams.** Limited information was obtained regarding the
2 nature of cold-run wastes derived from startup trials for Semi-Works processing.
3 Historical cold-run wastes are likely characterized by high salt content, low organics, and
4 as neutral to basic.

5
6 Unspecified wastes were also derived from the 201-C Process Building systems
7 decontamination which were conducted prior to conversion to new processes.
8 Information regarding the waste management units receiving other waste streams is
9 limited.

10 11 12 **2.4.2 Critical Mass Laboratory**

13
14 The Critical Mass Laboratory housed in the 209-E Building was in operation from
15 1960 to 1983 to conduct criticality experiments with plutonium nitrate and enriched
16 uranium solutions. Experiments were also performed using solid special nuclear
17 materials and fuels. During this time period, the number of experiments performed in
18 the Critical Mass Laboratory averaged 15 per year with a maximum of 50 a year (Nielsen
19 1990).

20
21 The laboratory generated mostly acidic liquid waste (neutron reflector tank water)
22 containing mainly cesium-137, ruthenium-106, strontium-90, plutonium, uranium, and
23 some nitrates (Nielsen 1990).

24
25 The 216-C-7 Crib received about 60,000 liters (16,000 gallons) of liquid waste from
26 the Critical Mass Laboratory transferred through the Critical Mass Laboratory Valve Pit.
27 No other waste management unit has been identified in the documents reviewed as
28 having received process waste from the laboratory.

29 30 31 **2.4.3 276-C Solvent Handling Facility**

32
33 The 276-C Solvent Handling Facility discharged radiologically contaminated, low-
34 level, low-salt neutral to basic organic wastes to the 216-C-4 Crib between 1955 and 1965.

35 36 37 **2.4.4 291-C Ventilation System Stack**

38
39 Between 1953 and 1988 low-salt, neutral to basic stack drainage and ventilation
40 filter seal water drainage were discharged to the 216-C-2 Reverse Well. The 291-C
41 Ventilation System discharged filtered exhaust air from the operation cell sand process
42 vessel vents through the 291-C stack.

2.4.5 215-C Gas Preparation Building and 271-C Aqueous Makeup and Control Building

The 215-C Gas Preparation Building and 271-C Aqueous Makeup and Control Buildings discharged acid wastes to the 216-C-3 Crib (along with similar wastes from the 201-C Process Building) between 1953 and 1954. Process cooling water from these buildings was sent to 216-C-9 Pond as waste.

2.5 INTERACTIONS WITH OTHER AGGREGATE AREAS OR OPERABLE UNITS

This section discusses the interaction of the Semi-Works Aggregate Area with other 200 Areas facilities and aggregate areas. The 200 Areas have two distinct operational areas, 200 East and 200 West. These are dedicated to chemical separations and waste management.

The Semi-Works Aggregate Area is bordered by the PUREX Aggregate Area on the east and north, and by the B Plant Aggregate Area on the west and south.

During operation of the 201-C Process Building, the Semi-Works Complex received spent reactor fuel rods from the reactors at the Hanford Site for reprocessing. Here, the plutonium was separated, purified, loaded out, and shipped off site to the Z Plant as a plutonium nitrate solution. According to DeFord (1992), megacurie quantities of strontium were recovered, purified, and loaded into casks for shipment off site, reportedly to the Oak Ridge National Laboratory.

Waste management units within the Semi-Works Aggregate Area which received waste from other operable units or aggregate areas include the 200 East Powerhouse Ditch and several transfer lines and valve boxes. This ditch receives water from the 201 East Powerhouse (284-E Power Plant) located in the 200 East Area. This wastewater contains dissolved solids in the form of sodium chloride, and oxygen-scavengers and anti-scaling compounds such as sodium sulfate and ethylenediaminetetraacetic acid (EDTA).

The Semi-Works Aggregate Area was connected to several other operations within the 200 East Area by transfer lines. DeFord (1992) reports that the 241-C-154 Diversion Box connected promethium lines from B Plant to various Semi-Works locations. The function of the Semi-Works Valve Pit was to connect lines from the 201-C Process Building and the 241-CX-70 Storage Tank to the 244-CR Vault in the PUREX Aggregate Area.

High-level wastes from the REDOX process were sent to the 241-C Tank Farm.

2.6 INTERACTION WITH RESOURCE CONSERVATION AND RECOVERY ACT PROGRAM

Two waste management units located within the Semi-Works Aggregate Area boundaries are subject to RCRA (and corresponding Washington State) regulations. A third waste management unit is currently under consideration for inclusion under the RCRA program. These units include:

- The 241-CX-70 Storage Tank is a TSD facility. This tank is currently identified in a Part A permit application;
- The 241-CX-71 Storage Tank has been identified as a TSD facility. A Part A identifying this tank has been sent to DOE-RL for approval and is scheduled for submittal to Ecology shortly thereafter; and
- The 241-CX-72 Storage Tank is currently being assessed for identification as a TSD facility. Sampling of the tank, expected to be performed within the next two years, will provide the information necessary to complete the Part A for submittal to Ecology.

It is expected that after these tanks are decontaminated and decommissioned, they will be permanently closed under the RCRA program. Following RCRA closure, further remediation of these tanks, if necessary, would be assessed through the AAMS process under CERCLA. Thus, there will be a need for interaction between future RCRA closure actions and the remediation actions recommended later in this report for the other Semi-Works Aggregate Area waste management units and unplanned releases.

2.7 INTERACTIONS WITH OTHER HANFORD PROGRAMS

In addition to RCRA, there are several other ongoing programs that affect buildings and waste management units in the Semi-Works Aggregate Area. These programs include: the Hanford Surplus Facilities Program; the Radiation Area Remedial Action Program; and the Defense Waste Management Program.

The Hanford Surplus Facilities Program is responsible for the safe and cost-effective surveillance, maintenance, and decommissioning of surplus facilities at the Hanford Site. All of the major inactive buildings within the Semi-Works Aggregate Area, and the 241-CX-70, 241-CX-71, and 241-CX-72 Storage Tanks are covered under this program.

1 The Radiation Area Remedial Action Program is conducted as part of the Surplus
2 Facilities Program, and is responsible for the surveillance, maintenance, decontamination,
3 and/or interim stabilization of inactive burial grounds, cribs, ponds, trenches, and
4 unplanned releases at the Hanford Site. A major concern associated with these
5 requirements is the management and control of surface soil contamination. All of the
6 controlled access surface radiation zones and the cribs in the Semi-Works Aggregate
7 Area are covered by this program.

8
9 The Defense Waste Management Program is responsible for all actively operating
10 waste management units in the Semi-Works Aggregate Area. These facilities include all
11 high-level waste process lines and their associated diversion boxes.
12

2F-1

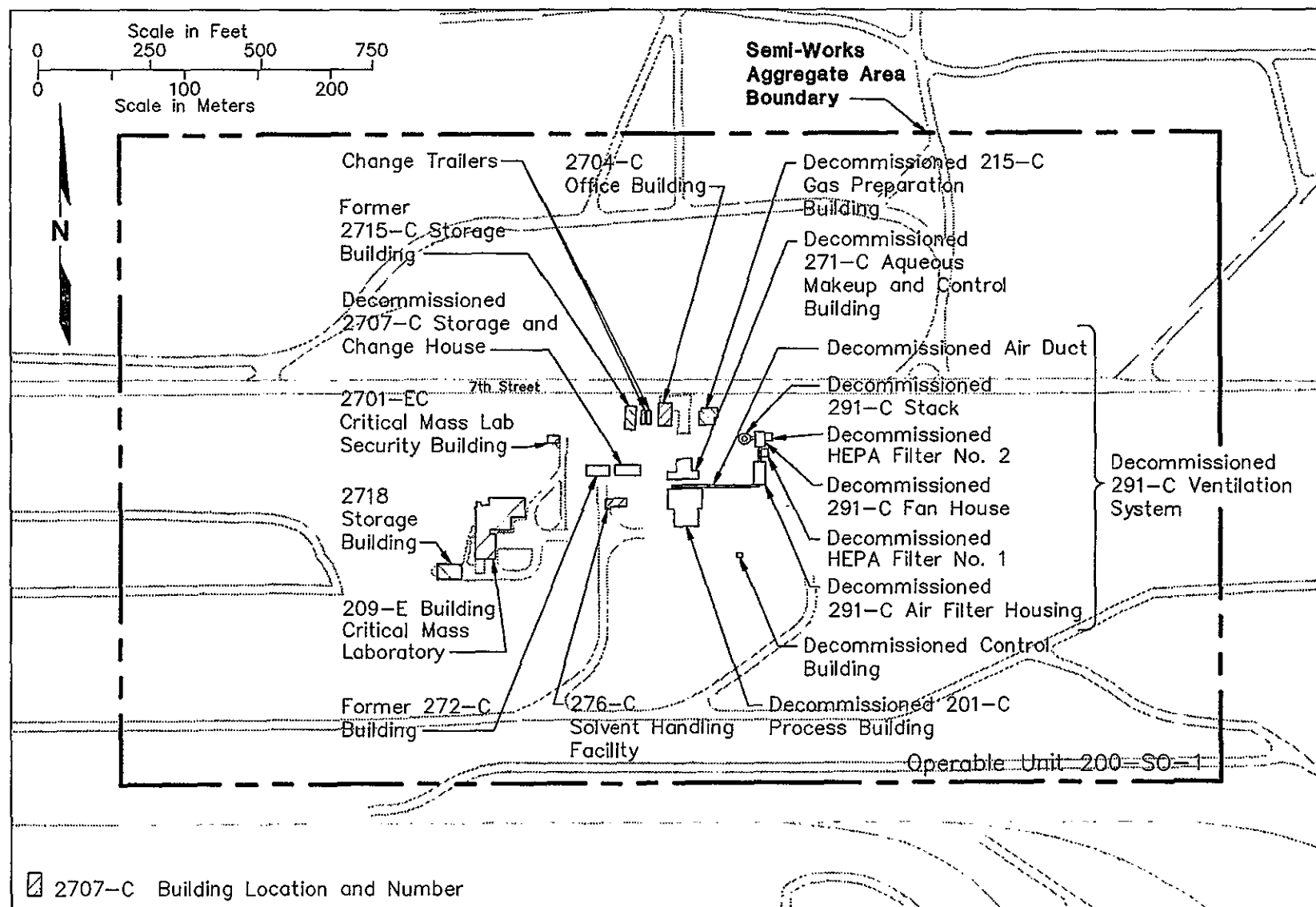
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Figure 2-1. Location of Plants, Buildings, and Storage Areas in the Semi-Work Aggregate Area.

2F-2

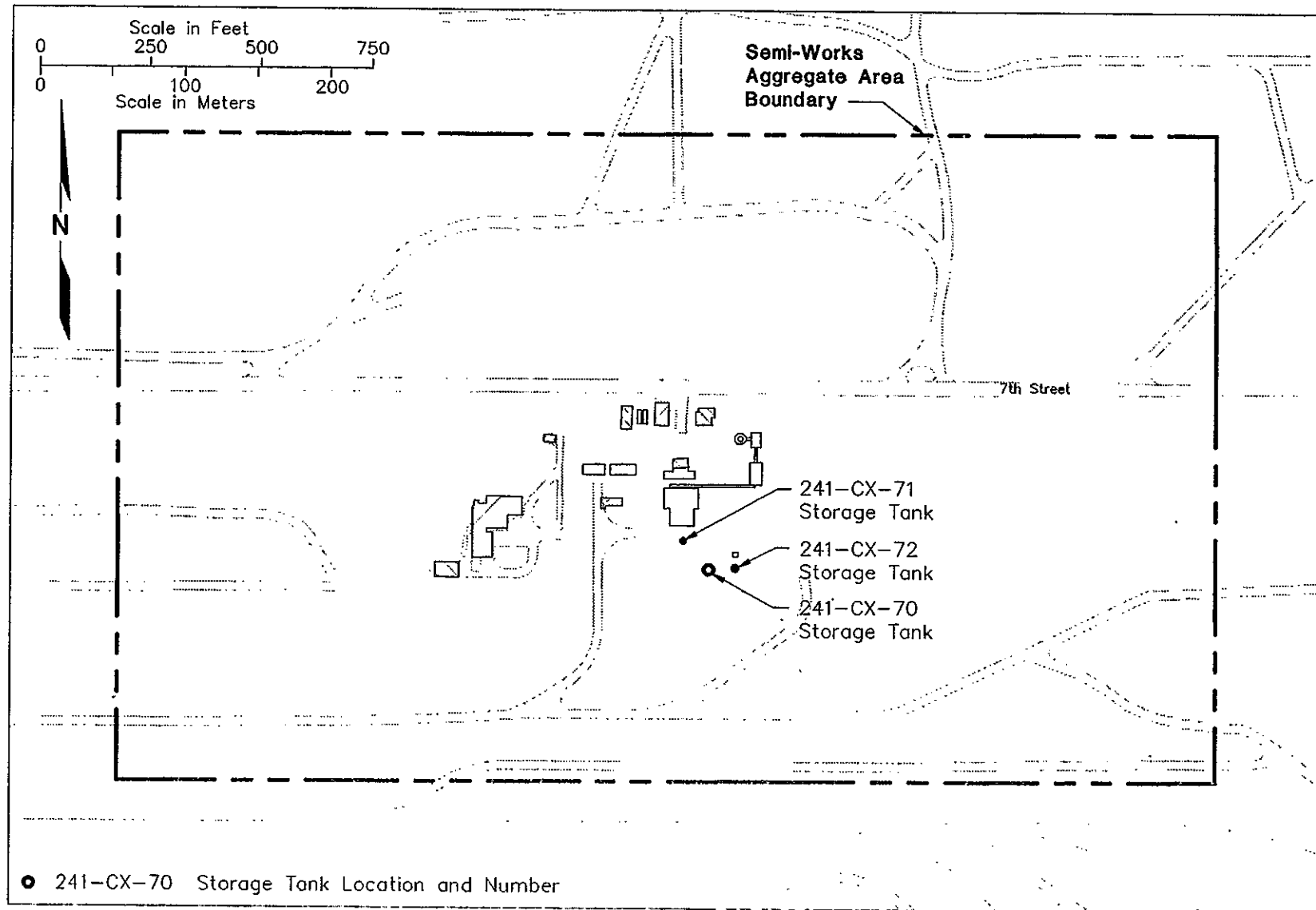
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Draft A

Figure 2-2. Location of Tanks and Vaults in the Semi-Works Aggregate Area.

2F-3

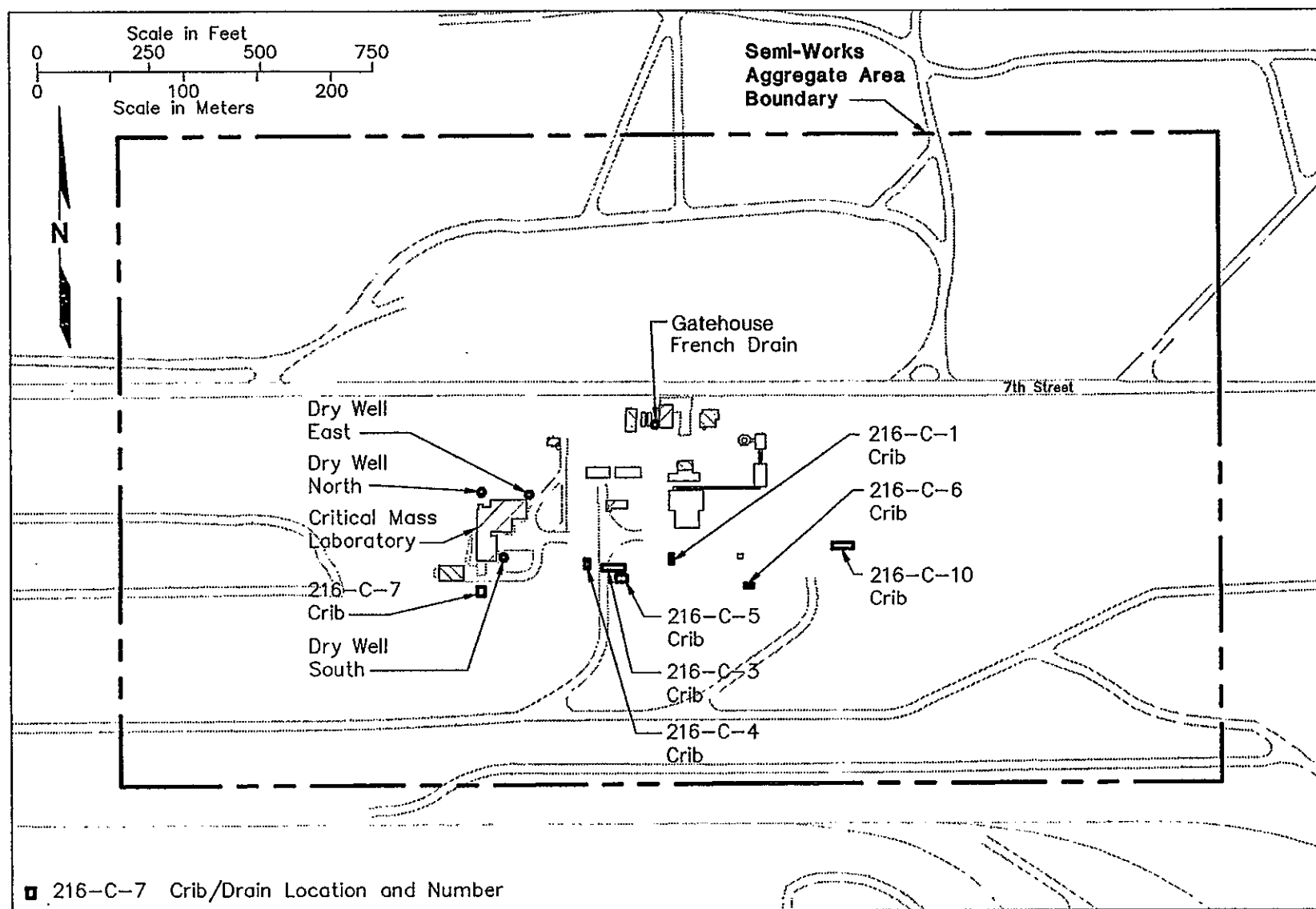
DOE/RL-92-18
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Figure 2-3. Location of Cribs and Drains in the Semi-Works Aggregate Area.

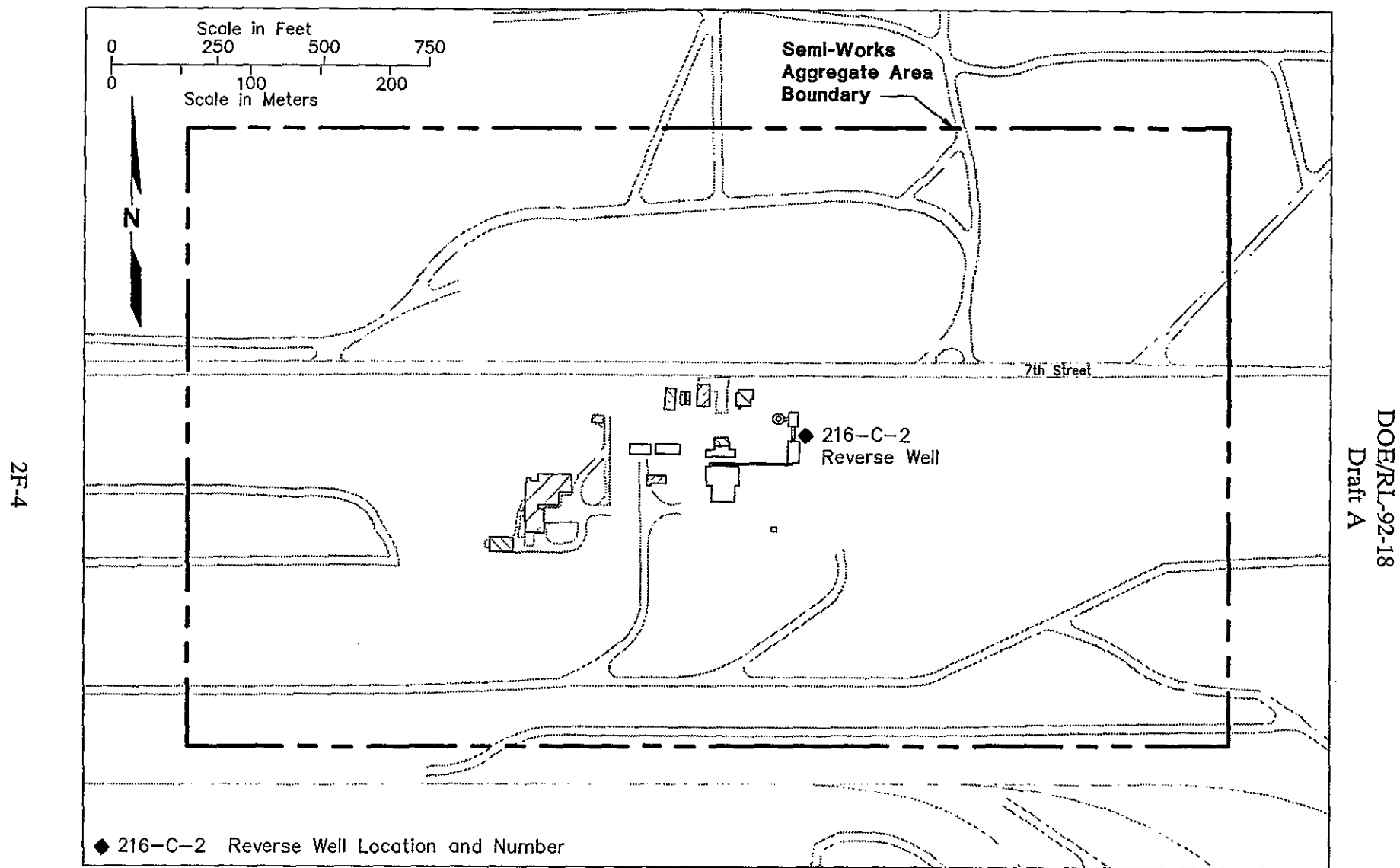


Figure 2-4. Location of Reverse Well in the Semi-Works Aggregate Area.

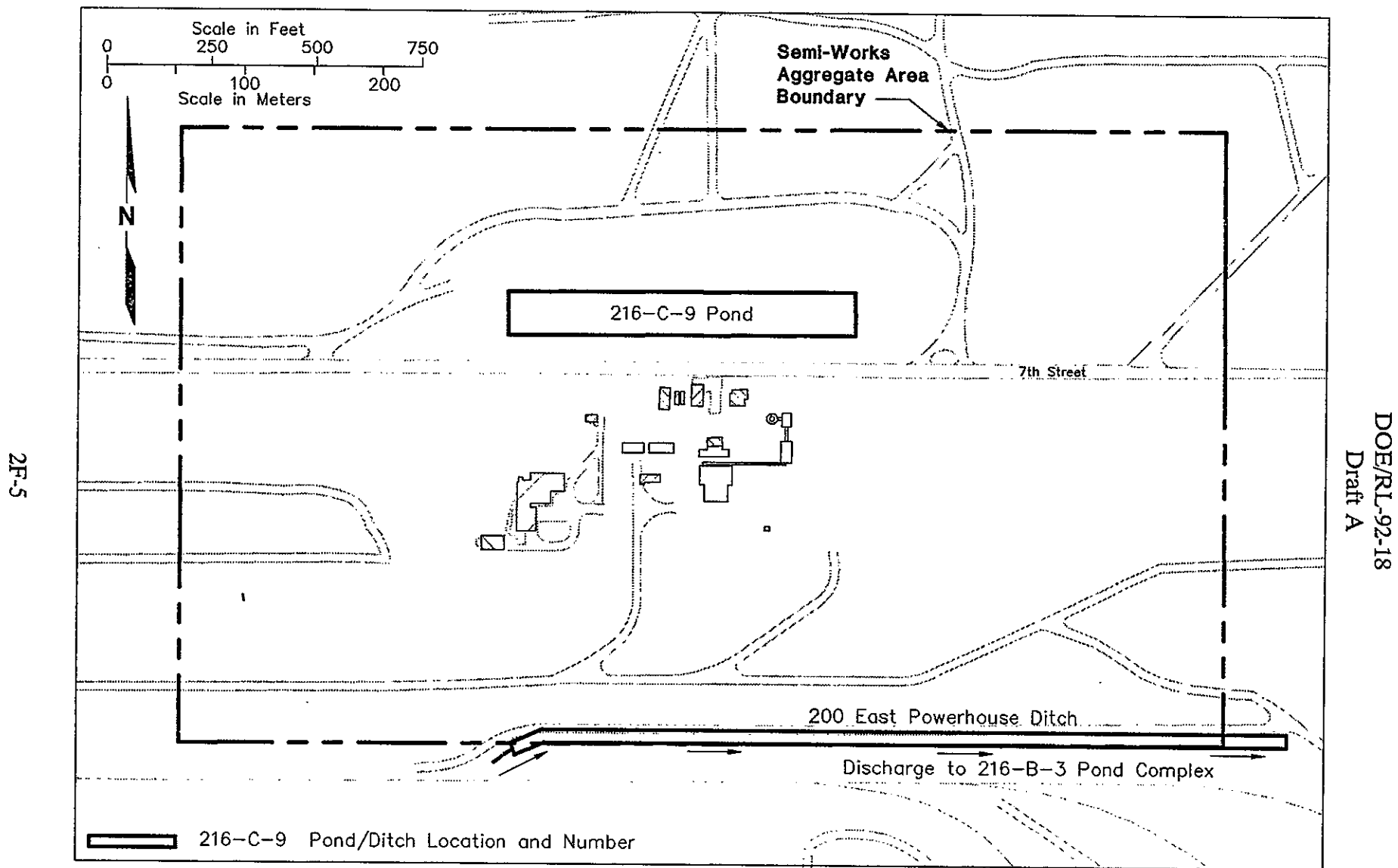


Figure 2-5. Location of Ponds, Ditches, and Trenches in the Semi-Works Aggregate Area.

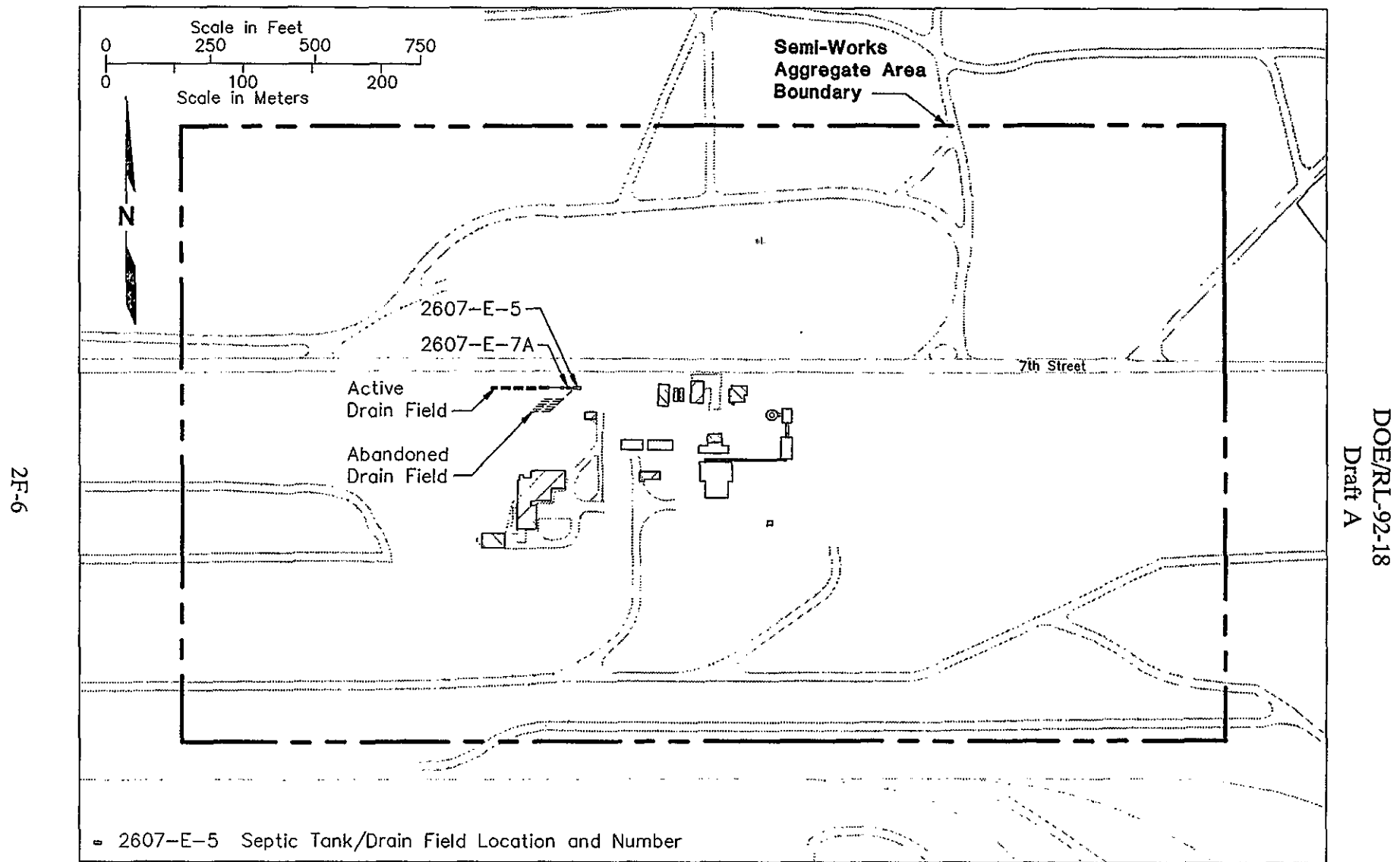


Figure 2-6. Location of Septic Tanks and Associated Drain Fields in the Semi-Works Aggregate Area.

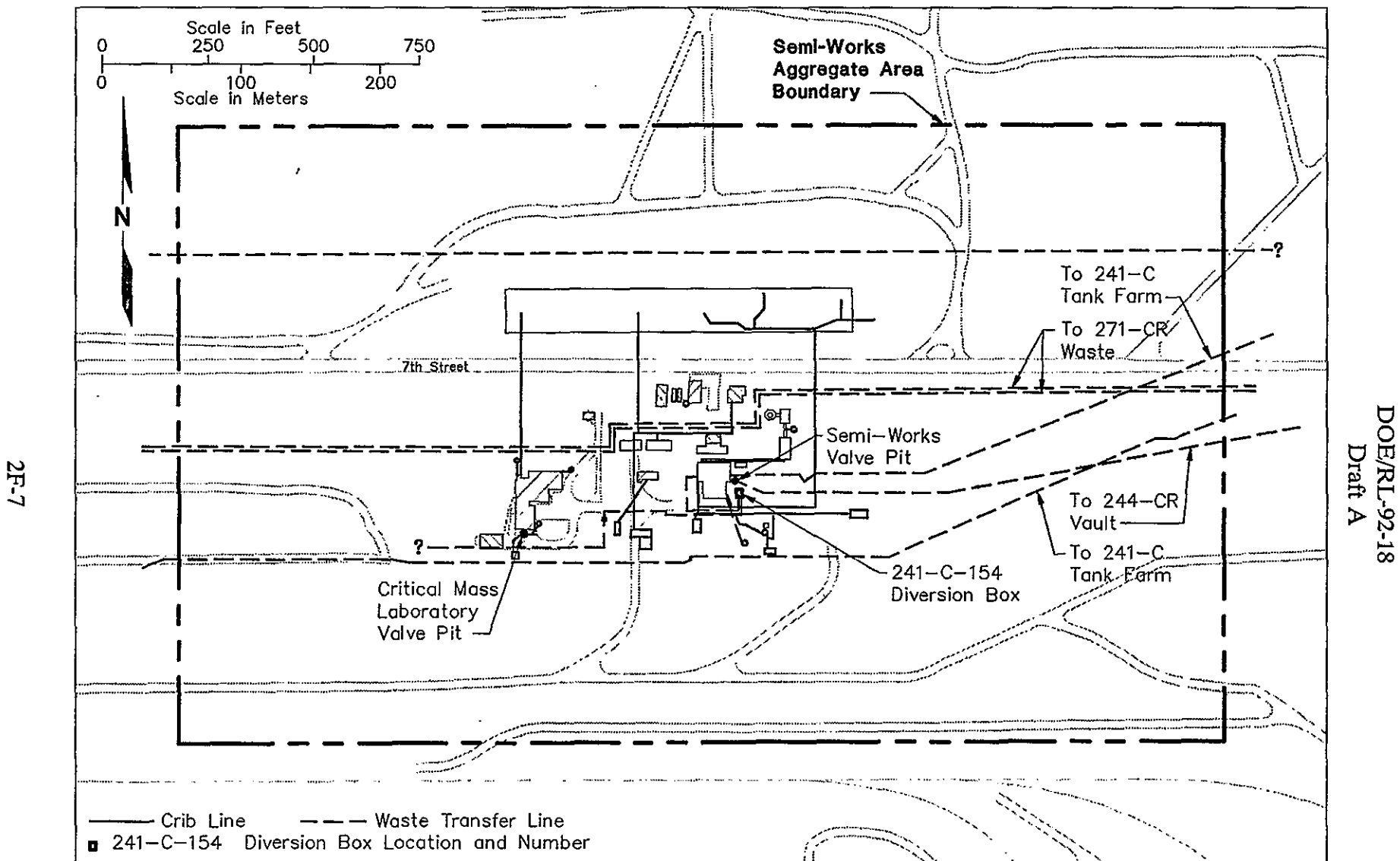


Figure 2-7. Location of Transfer Facilities, Diversion Boxes, and Pipelines in the Semi-Works Aggregate Area.

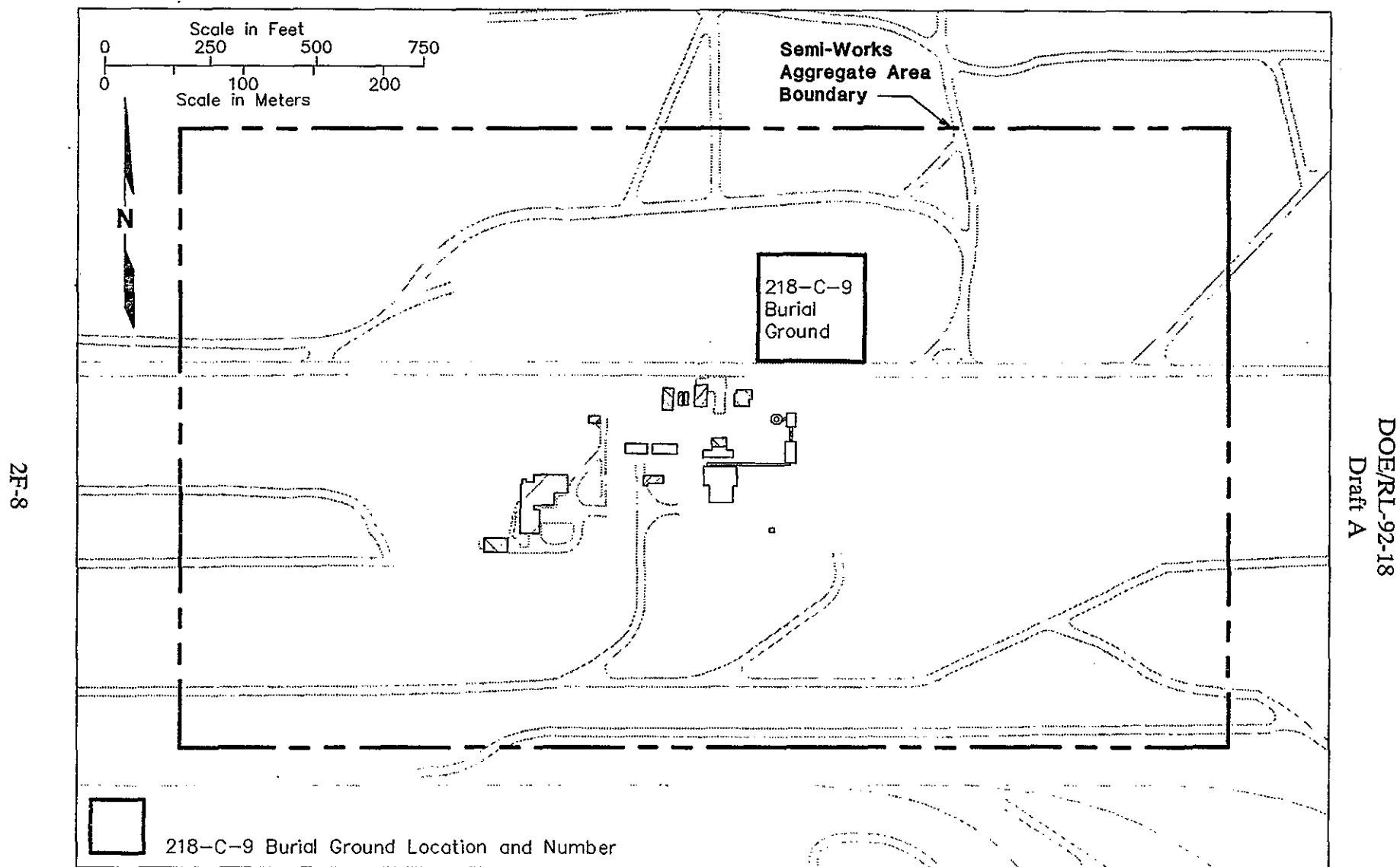


Figure 2-8. Location of Burial Sites in the Semi-Works Aggregate Area.

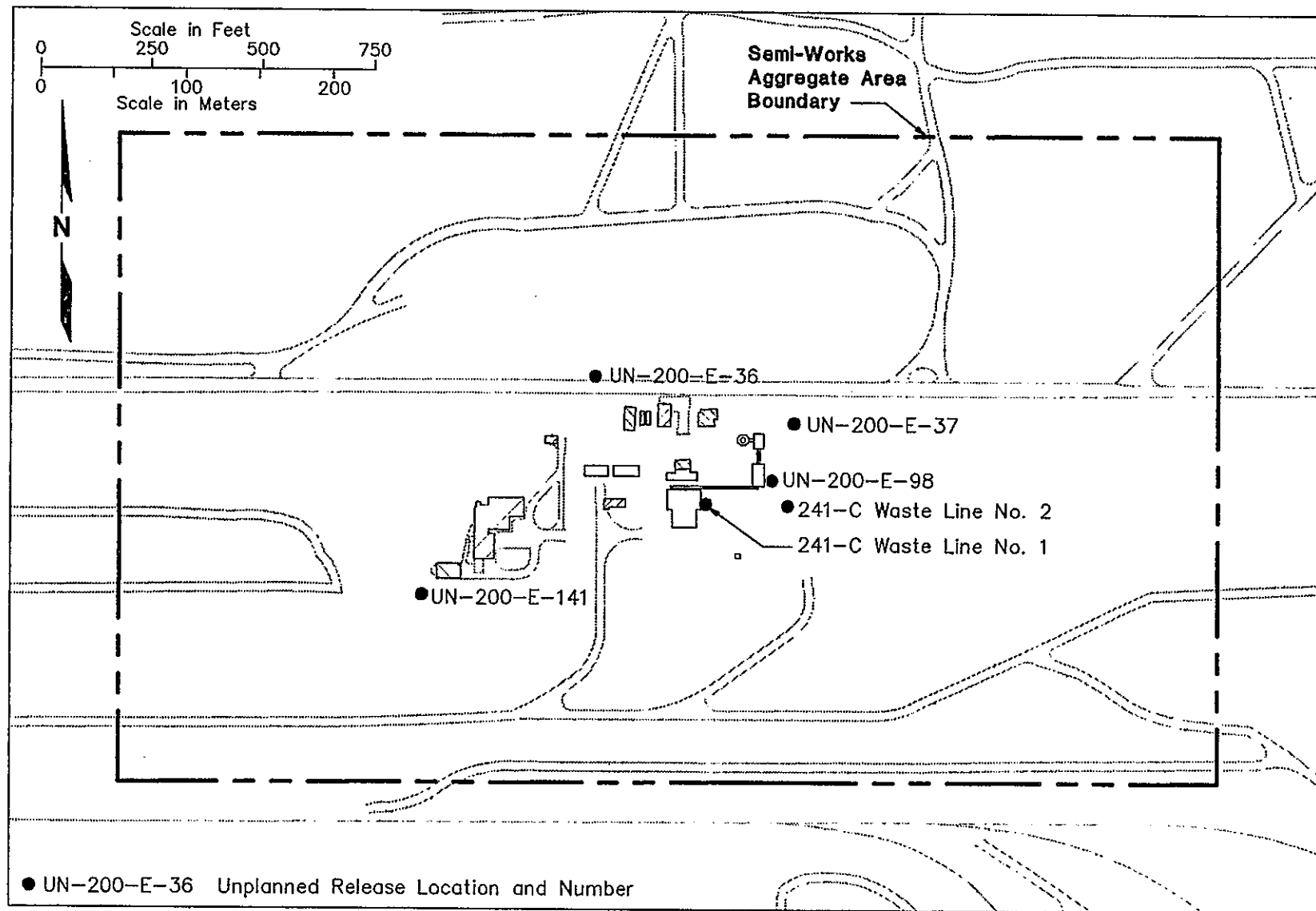
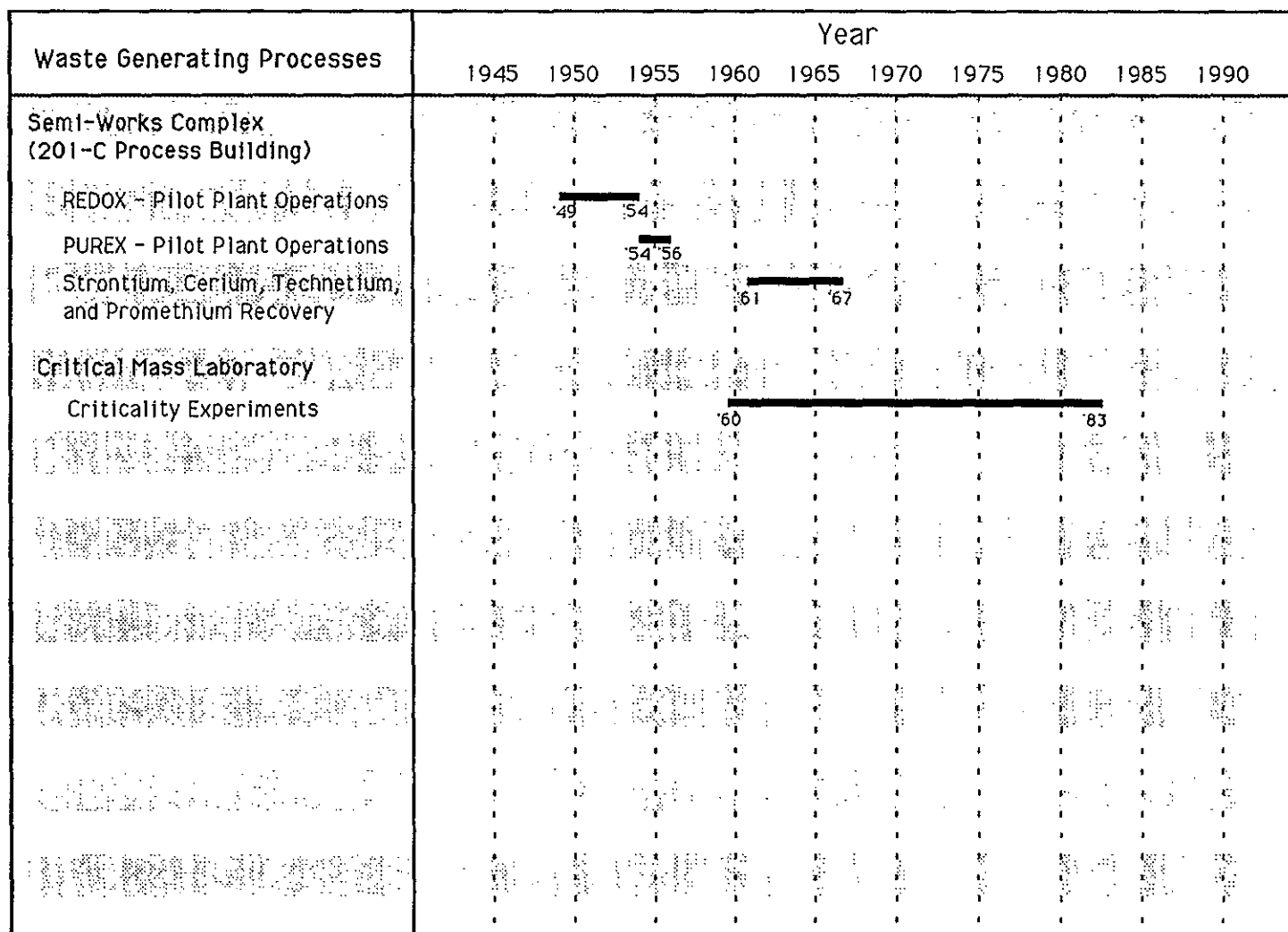


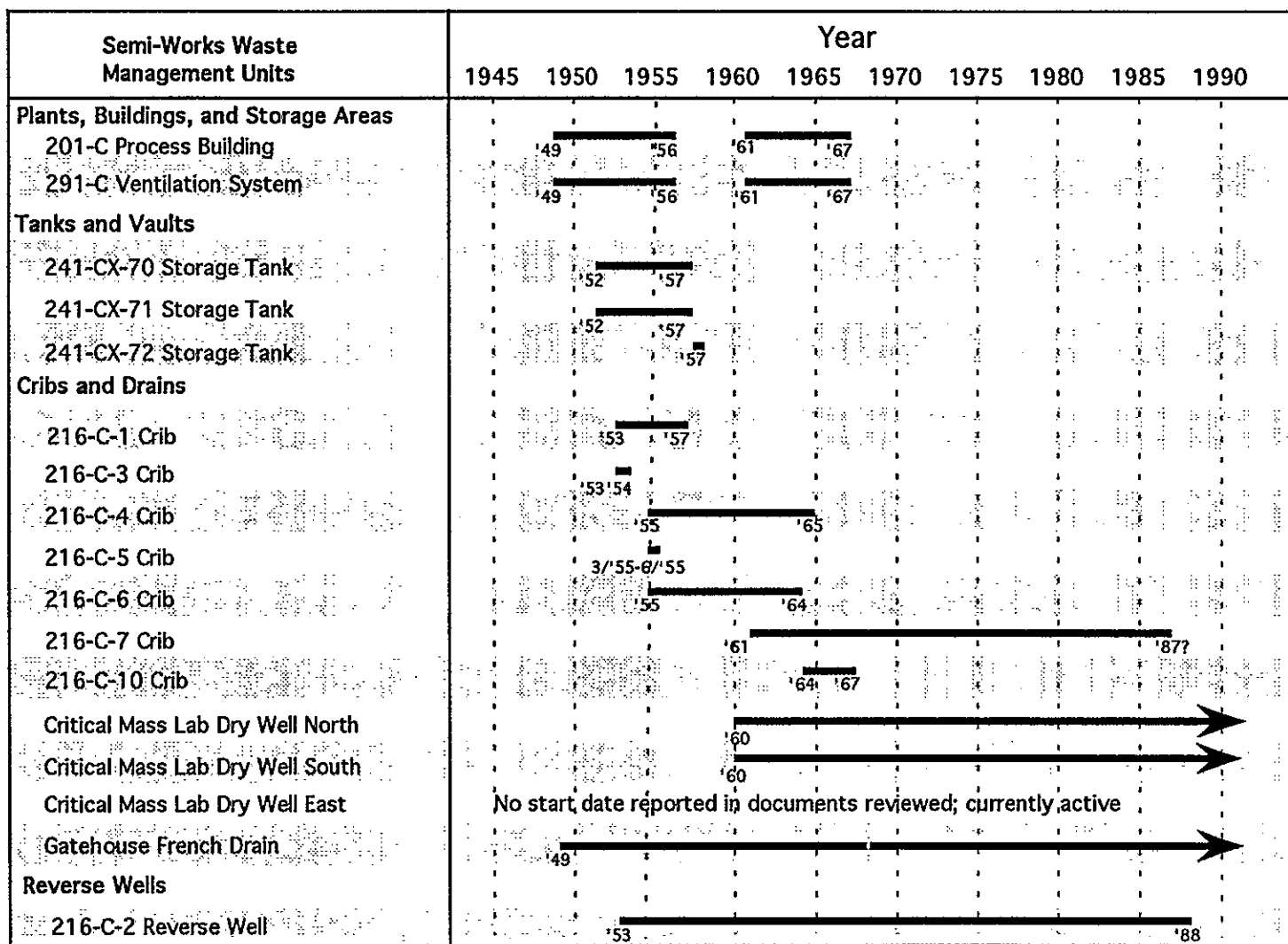
Figure 2-9. Location of Unplanned Releases in the Semi-Works Aggregate Area.



2F-10

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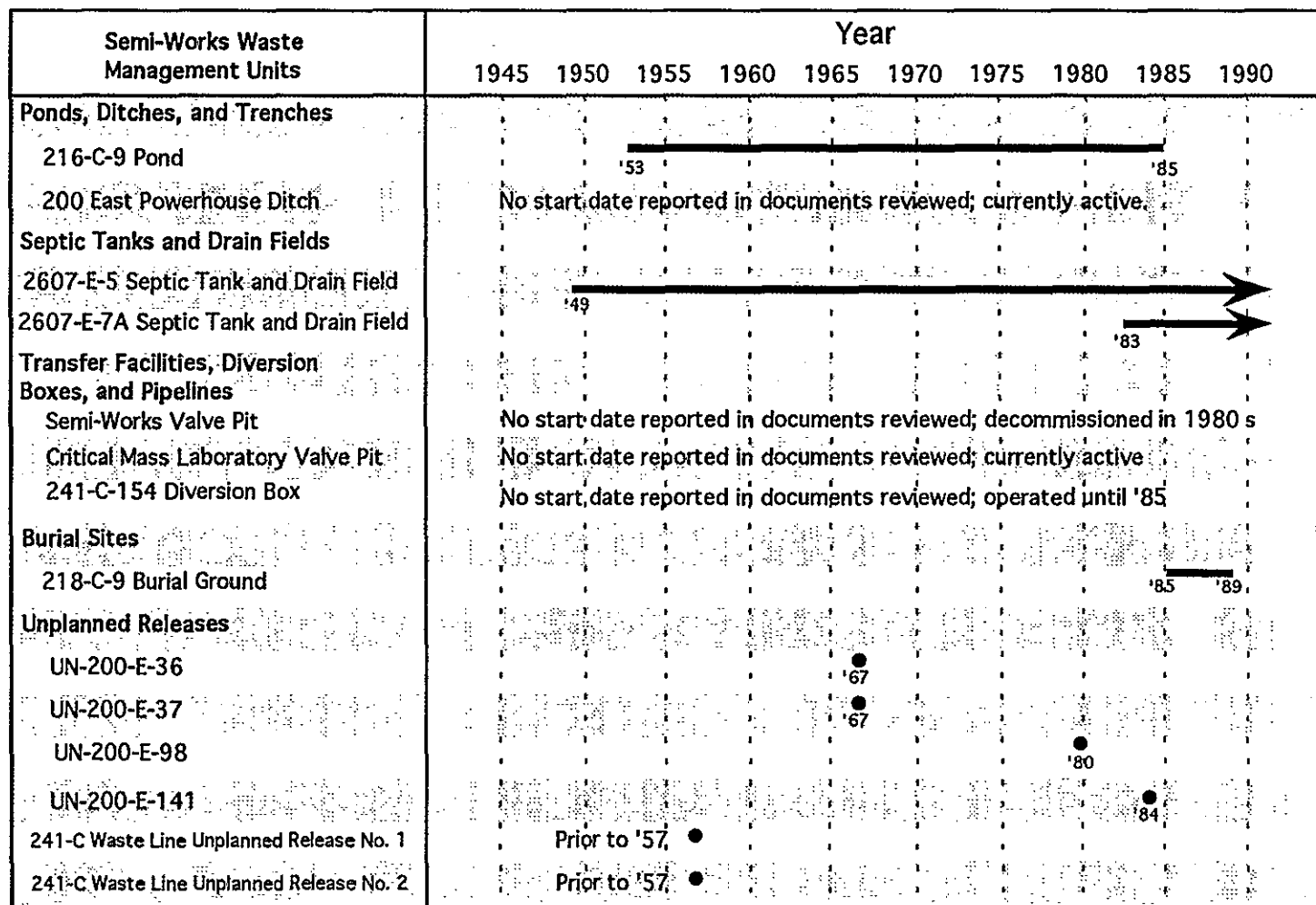
Figure 2-10. Semi-Works Process History.



2F-11a

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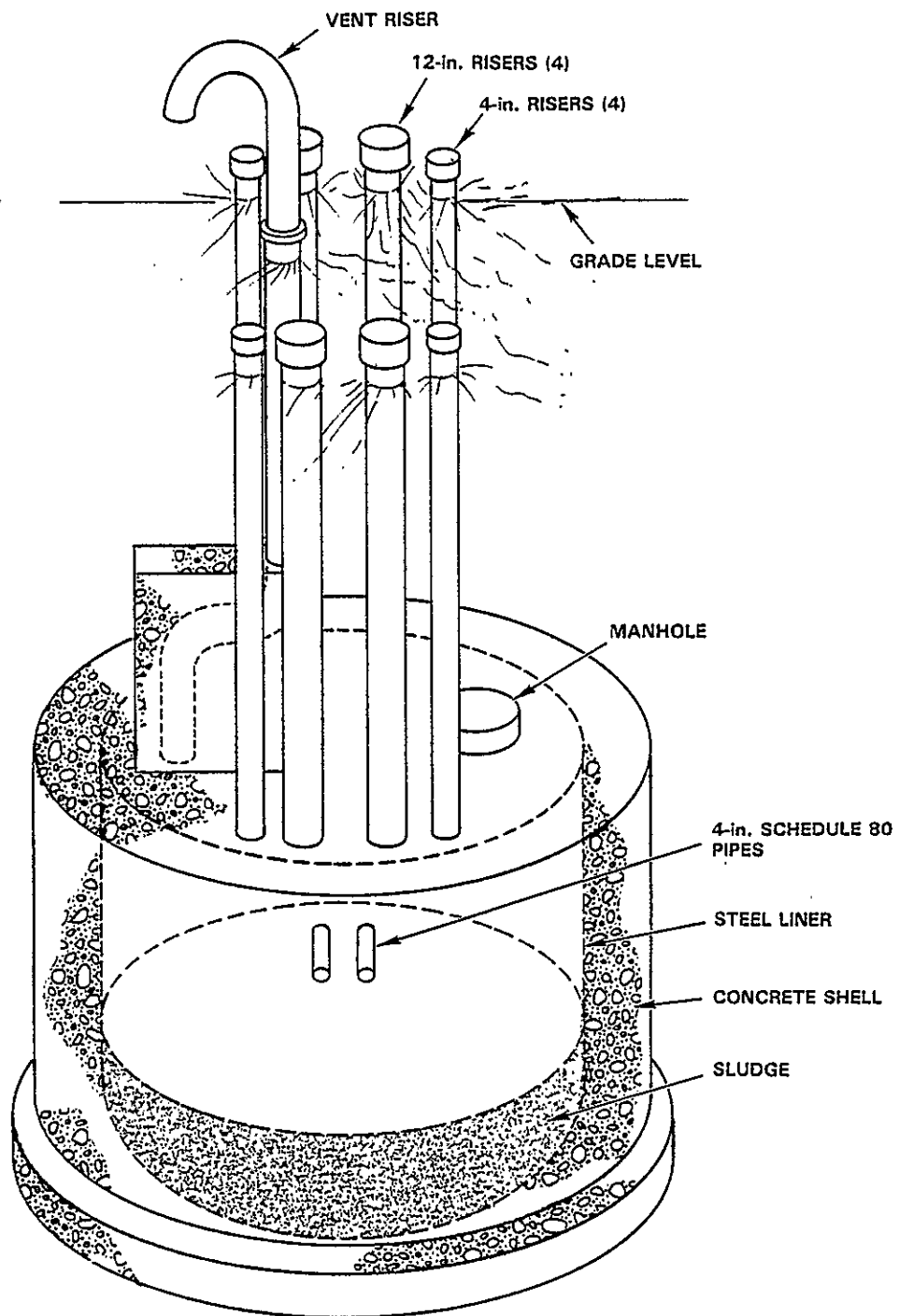
Figure 2-11. Waste Management Unit Operational History.



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Figure 2-11. Waste Management Unit Operational History.



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Figure 2-12. Schematic Diagram of 241-CX-70 Storage Tank.

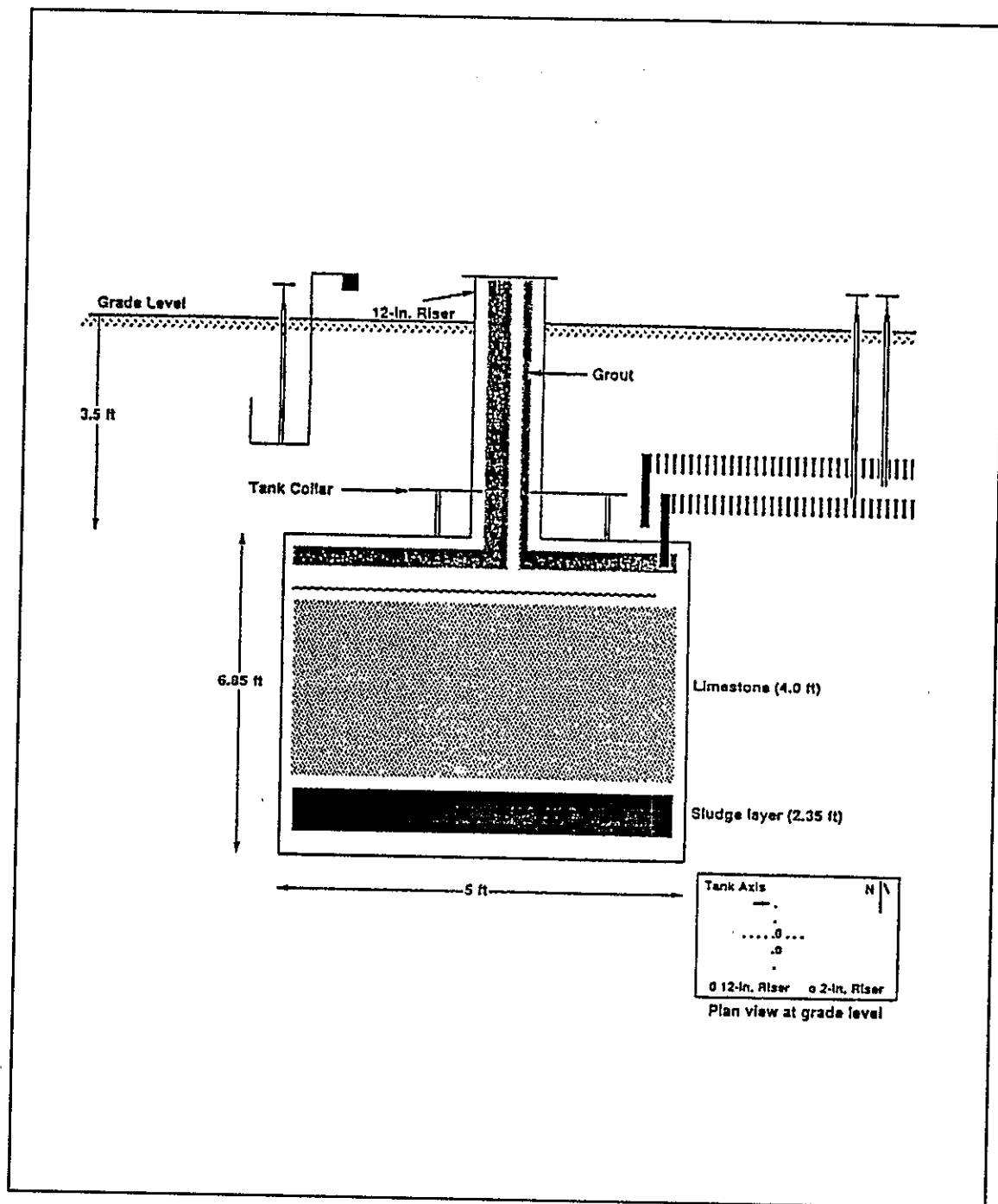


Figure 2-13. Schematic Diagram of 241-CX-71 Storage Tank.

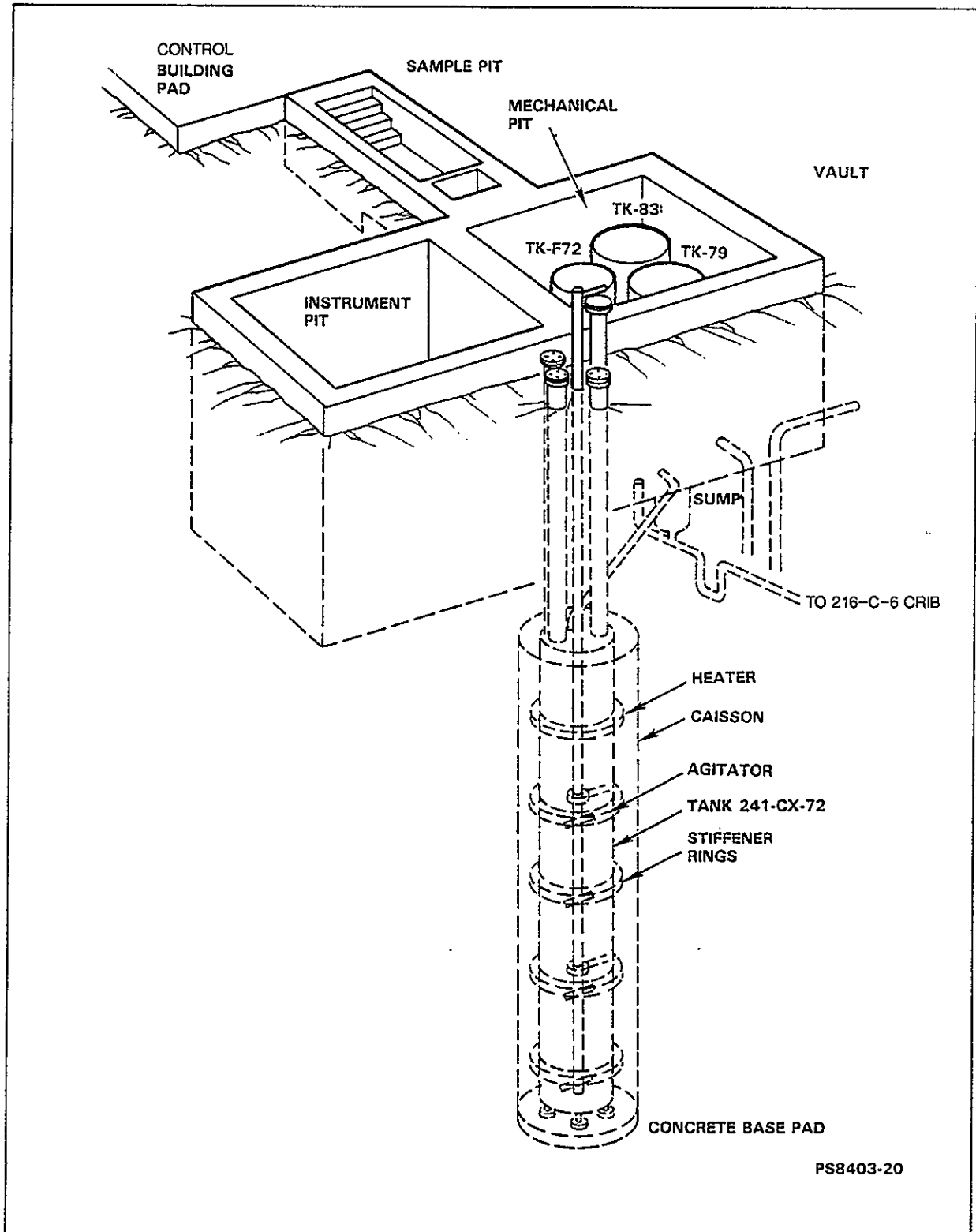


Figure 2-14. Schematic Diagram of 241-CX-72 Storage Tank.

Table 2-1. Summary of Semi-Works Aggregate Area Waste Management Units (Sheet 1 of 2).

Waste Management Unit	Years in Service	Source Description	Total Fluid Volume Received in Liters	Solid Waste Volume Received in m ³	Operable Unit
Plants, Buildings, and Storage Areas					
201-C Process Building	1949 - 1967	Processing Activities within 201-C Building	n/a	n/a	200-SO-1
291-C Ventilation System	1949 - 1967	Internal Filtering Activities	n/a	n/a	200-SO-1
Tanks and Vaults					
241-CX-70 Storage Tank	1952 - 1957	High level process waste	40,000 sludge (3)	n/a	200-SO-1
241-CX-71 Storage Tank (1)	1952 - 1957	201-C Building, Hot Shop	5,700 (3)	8.70	200-SO-1
241-CX-72 Storage Tank	1957	PUREX Pilot Plant	7,500	n/a	200-SO-1
Cribs and Drains					
216-C-1 Crib	1953 - 1957	201-C Building REDOX, PUREX Pilot Plant	23,400,000	n/a	200-SO-1
216-C-3 Crib	1953 - 1954	201-C Building, 215-C Building, 271-C Building	5,000,000	n/a	200-SO-1
216-C-4 Crib	1955 - 1965	276-C Building	170,000	n/a	200-SO-1
216-C-5 Crib	1955	201-C Building	37,900	n/a	200-SO-1
216-C-6 Crib	1955 - 1964	201-C Building, 241-CX vault floor drains	530,000	n/a	200-SO-1
216-C-7 Crib	1961 - 1987	Critical Mass Laboratory	60,000	n/a	200-SO-1
216-C-10 Crib	1964 - 1969	201-C Process Building	897,000	n/a	200-SO-1
Critical Mass Laboratory Dry Well North	1960 - present	209-E Critical Mass Laboratory			200-SO-1
Critical Mass Laboratory Dry Well South	1960 - present	209-E Critical Mass Laboratory			200-SO-1
Critical Mass Laboratory Dry Well East	? - present	209-E Critical Mass Laboratory			200-SO-1
Gatehouse French Drain	1949 - present	2704-C Office Building			200-SO-1
Reverse Wells					
216-C-2 Reverse Well	1953 - 1988	291-C Stack		n/a	200-SO-1

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Table 2-1. Summary of Semi-Works Aggregate Area Waste Management Units (Sheet 2 of 2).

Waste Management Unit	Years in Service	Source Description	Total Fluid Volume Received in Liters	Solid Waste Volume Received in m ³	Operable Unit
Ponds, Ditches, and Trenches					
216-C-9 Pond	1953 - 1985	209-E Building, 226-C, 201-C, 215-C, 209-C	1,030,000,000	n/a	200-SO-1
200 East Powerhouse Ditch (2)	? - present	284-E Power Plant	12,300,000 mo	n/a	200-SO-1
Septic Tanks and Associated Drain Fields					
2607-E-5 Septic Tank and Drain Field (2)	1949 - present	Critical Mass Laboratory, mobile offices		n/a	200-SO-1
2607-E-7A Septic Tank and Drain Field (2)	1983 - present	Critical Mass Laboratory		n/a	200-SO-1
Transfer Facilities, Diversion Boxes, and Pipelines					
Semi-Works Valve Pit (1)	? - late 1980s	201-C Process Building		n/a	200-SO-1
Critical Mass Laboratory Valve Pit (1)(2)	? - present	Critical Mass Laboratory		n/a	200-SO-1
241-C-154 Diversion Box (1)	? - 1985	Promethium transfer line from B Plant		n/a	200-SO-1
Burial Sites					
218-C-9 Burial Ground	1985 - 1989	Decommissioning rubble from 201-C Process Building		2,265	200-SO-1
Unplanned Releases					
UN-200-E-36	July 1967	Beta/gamma spill during transport			200-SO-1
UN-200-E-37	July 1967	Beta/gamma spill			200-SO-1
UN-200-E-98	Sept. 1980	Strontium 90 source			200-SO-1
UN-200-E-141	Sept. 1984	Uranyl nitrate spill	208.2	n/a	200-SO-1
241-C Waste Line Unplanned Release No. 1	prior to 1957	241-C Waste Line from 241-C Process Building to 241-C Tank Farm			200-SO-1
241-C Waste Line Unplanned Release No. 2	prior to 1957	241-C Waste Line from 241-C Process Building to 241-C Tank Farm			200-SO-1

Notes: (1) This waste management unit is not included in the Tri-Party Agreement (Ecology et al. 1991).
 (2) Reported as active by DeFord (1992).
 (3) Volume remaining after partial waste removal.
 Blank entries indicate no applicable data found during document review.
 n/a - not applicable

2T-1b

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Table 2-2. Semi-Works Aggregate Area Radionuclide Waste Inventory Summary. (Sheet 1 of 2)

		Quantity of Reported Radionuclides in Ci											
Waste Management Unit	Total Pu in gm	²³⁵ U	¹³⁷ Cs	¹⁰⁶ Ru	⁹⁰ Sr	⁶⁰ Co	³ H	¹⁴ C	¹⁵² Eu	Other Radionuclides	²³⁹ Pu	²⁴¹ Pu	²⁴⁰ Pu
Plants, Buildings, and Storage Areas													
201-C Process Building	68.3				9000(6)					²⁴¹ Am = 0.2(6)	3.7(6)	4.9(6)	
291-C Ventilation System (S)													
Tanks and Vaults													
241-CX-70 Storage Tank	55(8)		878(8) 500		4292(8) 2900							10	10
241-CX-71 Storage Tank (1)		0.0988(6)	0.0496(6)		93(6)	0.002(6)	70.0(6)					0.4579(6)	0.1230(6)
241-CX-72 Storage Tank	200	5.33E-7(4)	15000(8) 0		2.8E-6(4)								
Crisbs and Drains													
216-C-1 Crib	8.0	0.0988(3)	0.0455 0.0496(3)	1.89E-08	85.5 93.8(3)	0.002	70.0					0.4579	0.1230
216-C-3 Crib	1.0	0.0153(3)	0.0424 0.0924(3)	8.30E-11	8.04 8.83(3)	0.0014(3)							
216-C-4 Crib	1.0	0.0011(3)	0.0433 0.0472(3)	5.35E-10	11.8 13.0(3)	0.0018(3)							
216-C-5 Crib	1.0	0.0182(3)	0.0444 0.484(3)	1.38E-10	4.20 4.610(3)	0.0018(3)							
216-C-6 Crib	0.1	0.0001(3)	0.0465 0.0507(3)	2.73E-08	28.8 31.6(3)	0.0025							
216-C-7 Crib (2)	1.1	n/a	0.0534	1.06E-08	0.0512								
216-C-10 Crib	0.15	0.00001(3)	0.0855 0.0932(3)	8.95E-08	3.45 37.8(3)	0.0113(3)							
Critical Mass Laboratory Dry Well North													
Critical Mass Laboratory Dry Well South													
Critical Mass Laboratory Dry Well East													
Gatehouse French Drain													
Reverse Wells													
216-C-2 Reverse Well													

2T-2a

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Table 2-2. Semi-Works Aggregate Area Radionuclide Waste Inventory Summary. (Sheet 2 of 2)

		Quantity of Reported Radionuclides in Ci											
Waste Management Unit	Total Pu in gm	²³⁸ U	¹³⁷ Cs	¹⁰⁶ Ru	⁹⁰ Sr	⁶⁰ Co	³ H	¹⁴ C	¹⁵⁴ Eu	Other Radionuclides	²³⁸ Pu	²³⁹ Pu	²⁴⁰ Pu
Ponds, Ditches, and Trenches													
216-C-9 Pond	0.338		0.703	8.66E-08	2.43								
200 East Powerhouse Ditch (2)													
Septic Tanks and Associated Drain Fields													
2607-E-5 Septic Tank and Drain Field (2)													
2607-E-7A Septic Tank and Drain Field (2)													
Transfer Facilities, Diversion Boxes, and Pipelines													
Semi-Works Valve Pit (1)													
Critical Mass Laboratory Valve Pit (1)(2)													
241-C-154 Diversion Box (1)													
Burial Sites													
218-C-9 Burial Ground	1E-04(7)		8.1(7)	5.4E-06(7)				1E-06(7)					
Unplanned Releases													
UN-200-E-36													
UN-200-E-37													
UN-200-E-98													
UN-200-E-141													
241-C Waste Line Unplanned Release No. 1													
241-C Waste Line Unplanned Release No. 2													

Notes: Unless otherwise noted, data are obtained from WHC 1992.

- (1) This waste management unit is not included in the Tri-Party Agreement (Ecology et al. 1991).
- (2) This is an active unit.
- (3) Cummings 1989
- (4) Griffin and Ludowise 1989
- (5) DeFord 1992 reports an entombed inventory of 4.6 ci alpha and 6000 ci beta/gamma in the HEPA filter unit 1 and fiberglass filters.
- (6) DeFord 1992
- (7) WHC 1991c
- (8) Other sources

Blank entry indicates no applicable data found during document review.

Data is representative of decayed material.

Table 2-3. Semi-Works Aggregate Area Chemical Waste Inventory Summary. (Sheet 1 of 2)

Waste Management Unit	Quantity of Reported Chemical in Unit in kg				
	Tributyl Phosphonate	Nitrate	Sodium	Nitric Acid	Normal Paraffin Hydrocarbons
Plants, Buildings, and Storage Areas					
201-C Process Building (4)					
291-C Ventilation System					
Tanks and Vaults					
241-CX-70 Storage Tank (3) (5) (6)					
241-CX-71 Storage Tank (1) (8)					
241-CX-72 Storage Tank (7)					
Cribs and Drains					
216-C-1 Crib				15,000	
216-C-3 Crib		20			
216-C-4 Crib	14,000				24,000
216-C-5 Crib		8,000	3,000		
216-C-6 Crib		330			
216-C-7 Crib (2)		1			
216-C-10 Crib					
Critical Mass Laboratory Dry Well North					
Critical Mass Laboratory Dry Well South					
Critical Mass Laboratory Dry Well East					
Gatehouse French Drain					
Reverse Wells					
216-C-2 Reverse Well					
Ponds, Ditches, and Trenches					
216-C-9 Pond					
200 East Powerhouse Ditch (2)					
Septic Tanks and Associated Drain Fields					
2607-E-5 Septic Tank and Drain Field (2)					
2607-E-7A Septic Tank and Drain Field (2)					

Table 2-3. Semi-Works Aggregate Area Chemical Waste Inventory Summary. (Sheet 2 of 2)

Waste Management Unit	Quantity of Reported Chemical in Unit in kg				
	Tributyl Phosphonate	Nitrate	Sodium	Nitric Acid	Normal Paraffin Hydrocarbons
Transfer Facilities, Diversion Boxes, and Pipelines					
Semi-Works Valve Pit					
Critical Mass Laboratory Valve Pit (1)					
241-C-154 Diversion Box (1)					
Burial Sites					
218-C-9 Burial Ground					
Unplanned Releases					
UN-200-E-36					
UN-200-E-37					
UN-200-E-98					
UN-200-E-141					
241-C Waste Line Unplanned Release No. 1					
241-C Waste Line Unplanned Release No. 2					

- Notes: (1) This waste site is not included in the Tri-Party Agreement (Ecology et al. 1991).
 (2) This is an active unit.
 (3) Also 7.8 ton NaNO_3 ; 1.1 ton NaNO_2 ; 1.2 ton NaF ; 0.5 ton $\text{Al}_2(\text{SO}_4)_3$; 0.2 ton Na_2CrO_4
 (4) 201-C Process Building has 2.5 tons of lead entombed.
 (5) This tank is now empty. However, according to Holmes, 1988, an analysis was conducted on the sludge and yielded the following (in gms): $\text{Al} = 7.06\text{E}+6$; $\text{Fe} = 9.13\text{E}+5$; $\text{Na} = 3.01\text{E}+6$; $\text{Ni} = 1.92\text{E}+5$; $\text{NO}_3 = 3.29\text{E}+6$; $\text{Mg} = 2.0\text{E}+4$; $\text{Mn} = 6.74\text{E}+5$; $\text{PO}_4 = 3.88\text{E}+5$; $\text{Si} = 4.59\text{E}+5$
 (6) This waste unit received wastes from PUREX, REDOX, and decontamination flushes but no information is available as to the inventory of the tank contents.
 (7) This waste unit received wastes from PUREX and decontamination flushes but no information is available as to the inventory of the tank contents.
 (8) This waste unit received wastes from PUREX and decontamination flushes. Sample results are available as to the inventory of the tank contents, but a waste volume has not been calculated.

Blank entry indicates no applicable data found during document review.

Table 2-4. Summary of Unplanned Releases. (Sheet 1 of 2)

Unplanned Release No.	Location (Operable Unit)	Date	Associated Waste Management Unit	Reported Waste-Related History
UN-200-E-36	200-SO-1	July 24, 1967	201-C Process Building	<ul style="list-style-type: none"> ▶ Two pumps removed from the 201-C Process Building spilled during transit, contaminating the 7th Street roadway near the Hot Semi-Works plant. ▶ The spill covered 274 m (900 ft) in length and 137 m (450 ft) in width. Beta/gamma readings of 30,000 to 80,000 ct/min were measured. ▶ For remedial measures, the roadways were flushed with water and a program for decontamination was initiated.
UN-200-E-37	200-SO-1	July 31, 1967	n/a	<ul style="list-style-type: none"> ▶ This unplanned release was the result of cleanup efforts for the UN-200-E-36 Unplanned Release. The location was an area east of Semi-Works Aggregate Area on a road outside the east fence. ▶ The dimensions of the area impacted by the spill were 183 m (600 ft) in length. Beta/gamma readings to 200 mRem/hr were measured. ▶ For remedial measures, sprinklers were set in the contaminated areas and the blacktop was cleaned.
UN-200-E-98	200-SO-1	September 1980	201-C Process Building	<ul style="list-style-type: none"> ▶ Radioactive particulate matter from the hot semi-works building ventilation was inadvertently spread to the ground surface near the base of the 291-C-1 Stack and around the 216-C-2 Reverse Well. ▶ The actual area impacted was unknown. The waste type identified was primarily strontium. ▶ WIDS indicates that the contamination was removed and the area was stabilized.

Table 2-4. Summary of Unplanned Releases. (Sheet 2 of 2)

Unplanned Release No.	Location (Operable Unit)	Date	Associated Waste Management Unit	Reported Waste-Related History
UN-200-E-141	200-SO-1	September 1984	2718-E Building	<ul style="list-style-type: none"> ▶ A release occurred from a container failure due to erosion of the container. The release occurred in the storage area near the 2718-E Building. ▶ The waste volume released was 208 liters. The release consisted of 450 g/L solution of uranyl nitrate (corrosive), 84% ²³⁵U. ▶ For remedial measures, all liquids were removed from the storage area in the 2718-E Building. The contaminated asphalt and soil were removed until background levels of contamination were reached.
241-C Waste Line Unplanned Release No. 1	200-SO-1	Prior to 1957	Immediately west of 201-C Process Building	<ul style="list-style-type: none"> ▶ Release was a result of a flange leak in the 241-C Waste Line. Actual area impacted is unknown. ▶ Radiation readings of >100 Rad/hr were reported at a depth of 3.7 m (12 ft). ▶ No WIDS data, currently under ash barrier.
241-C Waste Line Unplanned Release No. 2	200-SO-1	Prior to 1957	241-CX Fence Line west of 201-C Process Building	<ul style="list-style-type: none"> ▶ Release occurred as a result of a flange leak in the 241-C Waste Line. ▶ The release was reported to have contaminated subsurface soils along the fence. Actual area impacted is unknown. ▶ Radiation levels >100 Rad/hr were reported 4.6 m (15 ft) below the surface. ▶ No WIDS data or recent surveys are available.

Notes:

n/a - Not applicable

2T-4b

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Table 2-5. Summary of Waste Producing Processes in the Semi-Works Aggregate Area (Sheet 1 of 3)

Process	Waste Generated	Major Chemical Constituents	Ionic Strength	pH	Organic Concentration	Radioactivity
REDOX and PUREX Pilot Plants (201-C Process Building)	Aluminum coating waste	sodium hydroxide, sodium aluminate, sodium nitrate, sodium nitrite, sodium silicate, uranium, plutonium	High	neutralized acidic waste	Low	Low-High
	Zircaloy coating	aluminum nitrate zirconium oxide, sodium fluoride, sodium nitrate, potassium fluoride, uranium, plutonium	High	neutralized acidic waste	Low	Low-High
	Radioactive condensates	cesium-137, ruthenium-106, strontium-90, plutonium-239, uranium, tritium, cobalt-60, uranium-238, nitric acid, other inorganic contaminants	High	acidic (neutralized)	Low	Low-High
	Hot Shop sink wastes					
	Cold-run wastes		High	neutral/basic	Low	

Table 2-5. Summary of Waste Producing Processes in the Semi-Works Aggregate Area (Sheet 2 of 3)

Process	Waste Generated	Major Chemical Constituents	Ionic Strength	pH	Organic Concentration	Radioactivity
REDOX and PUREX Pilot Plants (cont.)	REDOX Spent solvent	Hexone	Low	neutral/basic	High	Low
	Other REDOX wastes	sodium aluminate, sodium hydroxide, sodium nitrate, chromate, sodium sulfate, ferric hydroxide, plutonium, uranium	Low		Low	Low-High
	PUREX Organic Wash waste	Sodium nitrate, sodium carbonate, manganese oxide, uranium	High	neutralized acidic waste	High	High
	PUREX acid process waste	Nitric acid, ferrous sulfate, ferrous phosphate, sodium, aluminum	High	acidic (neutralized)	Low	High
	PUREX Spent solvent waste	tributyl phosphate, kerosene	Low	neutral	High	Low
Strontium Recovery Pilot Plant (201-C Process Building)	Process waste	Hydrochloric acid, nitric acid, di-2-ethylhexyl-phosphoric acid		acidic (neutralized)	High	High
Critical Mass Laboratory (209-E Building)	Neutron reflector tank water	cesium-137, ruthenium-106, strontium-90, plutonium, uranium, nitrates		acidic		Low

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Table 2-5. Summary of Waste Producing Processes in the Semi-Works Aggregate Area (Sheet 3 of 3)

Process	Waste Generated	Major Chemical Constituents	Ionic Strength	pH	Organic Concentration	Radioactivity
276-Solvent Handling Facility			Low	neutral/basic	High	Low
291-C Ventilation Stack	Condensate and seal water drainage		Low	neutral/basic	Low	Low
215-Gas Preparation Building, and 271-Aqueous Makeup and Control Building				acidic		

Notes:

Blank spaces indicate no information was located in documents reviewed.

Table 2-6. Partial List of Chemicals Used in the
Semi-Works Aggregate Area. (Sheet 1 of 2)

COMPOUND NAME
Acetic acid
Aluminum sulfate
Aluminum nitrate nonahydrate (ANN)
Ammonium fluoride
Ammonium nitrate
Calcium nitrate
Caustic tartrate (CT)
Chromium nitrate
Citric acid
Di-2-ethylhexyl phosphoric acid
Ethylenediamine tetraacetate (EDTA)
Ferric nitrate
Ferric sulfate
Ferrous sulfamate
Glycolic acid
Hexone
Hydrazine
Hydrogen peroxide
Kerosene
Lead nitrate
Manganese oxide
Nickel nitrate
Nitric acid
Nitric ferrous ammonium sulfate
Nitrilotriacetic acid (NTA)
Nonylphenoxy polyethoxy ethanol
Normal paraffin hydrocarbon (NPH)
Oxalic acid
Pentasodium diethylene
Triamine penta acetate
Permanganate caustic
Phosphoric acid
Potassium bicarbonate
Potassium nitrate
Potassium permanganate
Potassium persulfate

Table 2-6. Partial List of Chemicals Used in the
Semi-Works Aggregate Area. (Sheet 2 of 2)

COMPOUND NAME
Shell spray base
Shell E-2342 ^{®1}
Silver nitrate
Sodium acetate
Sodium aluminate
Sodium carbonate
Sodium dichromatic
Sodium hexametaphosphate
Sodium fluoride
Sodium hydroxide
Sodium nitrate
Sodium nitrite
Sodium persulfate
Sodium phosphate
Sodium silicate
Sodium sulfate
Sodium sulfide
Soltrol-170 ^{®2}
Sugar
Sulfamic acid
Sulfuric acid
Tartaric acid
Tetrasodium ethylene diamine-tetra acetate (EDTA)
Tributyl phosphate (TBP)
Trisodium hydroxyethyl ethylene-diamine triacetate (HEDTA)
Trisodium phosphate
Turco 4128A ^{®3}
Zirconium oxide

¹ Trademark of Shell Oil Company

² Trademark of Phillips Petroleum Company

³ Trademark of Turco Products Incorporated

3.0 SITE CONDITIONS

The following sections describe the physical nature and setting of the Hanford Site, the 200 East Area, and the Semi-Works Aggregate Area. The site conditions are presented in the following sections:

- Physiography and Topography (Section 3.1)
- Meteorology (Section 3.2)
- Surface Hydrology (Section 3.3)
- Geology (Section 3.4)
- Hydrogeology (Section 3.5)
- Environmental Resources (Section 3.6)
- Human Resources (Section 3.7).

Sections describing topography, geology, and hydrogeology have been taken from standardized texts provided by Westinghouse Hanford (Delaney et al. 1991 and Lindsey et al. 1992) for that purpose.

3.1 PHYSIOGRAPHY AND TOPOGRAPHY

The Hanford Site (Figure 3-1) is situated within the Pasco Basin of southcentral Washington. The Pasco Basin is one of a number of topographic depressions located within the Columbia Basin Subprovince of the Columbia Intermontane Province (Figure 3-2), a broad basin located between the Cascade Range and the Rocky Mountains. The Columbia Intermontane Province is the product of Miocene continental flood basalt volcanism and regional deformation that occurred over the past 17 million years. The Pasco Basin is bounded on the north by the Saddle Mountains, on the west by Umtanum Ridge, Yakima Ridge, and the Rattlesnake Hills, on the south by Rattlesnake Mountain and the Rattlesnake Hills, and on the east by the Palouse slope (Figure 3-1).

The physiography of the Hanford Site is dominated by the low-relief plains of the Central Plains physiographic region and anticlinal ridges of the Yakima Folds physiographic region (Figure 3-3). Surface topography seen at the Hanford Site is the result of (1) uplift of anticlinal ridges, (2) Pleistocene cataclysmic flooding, (3) Holocene

1 eolian activity, and (4) landsliding. Uplift of the ridges began in the Miocene epoch and
2 continues to the present. Cataclysmic flooding occurred when ice dams in western
3 Montana and northern Idaho were breached, allowing large volumes of water to spill
4 across eastern and central Washington. The last major flood occurred about 13,000 years
5 ago, during the late Pleistocene Epoch. Anastomosing flood channels, giant current
6 ripples, bermounds, and giant flood bars are among the landforms created by the floods.
7 Since the end of the Pleistocene Epoch, winds have locally reworked the flood sediments,
8 depositing dune sands in the lower elevations and loess (windblown silt) around the
9 margins of the Pasco Basin. Generally, sand dunes have been stabilized by anchoring
10 vegetation except where they have been reactivated where vegetation is disturbed (Figure
11 3-4).

12
13 A series of numbered areas have been delineated at the Hanford Site. The 100
14 Areas are situated in the northern part of the Site adjacent to the Columbia River in an
15 area commonly called the "Horn." The elevation of the Horn is between 119 and 143 m
16 (390 and 470 ft) above mean sea level (msl) with a slight increase in elevation away from
17 the river. The 200 Areas are situated on a broad flat area called the 200 Areas Plateau.
18 The 200 Areas Plateau is near the center of the Hanford Site at an elevation of
19 approximately 198 to 229 m (650 to 750 ft) above msl. The plateau decreases in
20 elevation to the north, northwest, and east toward the Columbia River, and plateau
21 escarpments have elevation changes of between 15 to 30 m (50 to 100 ft).

22
23 The 200 East Area is situated on the 200 Areas Plateau on a relatively flat
24 prominent terrace (Cold Creek Bar) formed during the late Pleistocene flooding (Figure
25 3-5). Cold Creek Bar trends generally east to west and is bisected by a flood channel
26 that trends north to south. This terrace drops off rather steeply to the north and
27 northwest with elevation changes between 15 and 30 m (50 to 100 ft).

28
29 The topography of the 200 East Area is generally flat (Figure 3-1). The elevation
30 in the vicinity of the Semi-Works Aggregate Area ranges from approximately 65 m (214
31 ft) in the southwestern part of the unit to about 62 m (205 ft) above msl in the
32 northeastern part. A detailed topographic map of the area is provided on Figure 3-6 and
33 Plate 1. There are no natural surface drainage channels within the area.

34 35 36 3.2 METEOROLOGY

37
38 The following sections provide information on Hanford Site meteorology including
39 precipitation (Section 3.2.1), wind conditions (Section 3.2.2), and temperature variability
40 (Section 3.2.3).

1 The Hanford Site lies east of the Cascade Mountains and has a semiarid climate
2 because of the rainshadow effect of the mountains. The weather is monitored at the
3 Hanford Meteorology Station, located between the 200 East and 200 West Areas, and at
4 other points situated through the reservation. The following sections summarize the
5 Hanford Site meteorology.

8 3.2.1 Precipitation

10 The Hanford Site receives an annual average of 16 cm (6.3 in.) of precipitation.
11 Precipitation falls mainly in the winter, with about half of the annual precipitation
12 occurring between November and February. Average winter snowfall ranges from 13 cm
13 (5.3 in.) in January to 0.8 cm (0.31 in.) in March. The record snowfall of 62 cm (24.4 in.)
14 occurred in February 1916 (Stone et al. 1983). December through February snowfall
15 accounts for about 38% of all precipitation in those months.

17 The average yearly relative humidity at the Hanford Site for 1946 to 1980 was 54.4
18 percent. Humidity is higher in winter than in summer. The monthly averages for the
19 same period range from 32.2% for July to 80% in December. Atmospheric pressure
20 averages are generally higher in the winter months, although both record highs and lows
21 occurred in winter.

24 3.2.2 Winds

26 The Cascade Mountains have considerable effect on the wind regime at the
27 Hanford Site by serving as a source of cold air drainage. This gravity drainage results in
28 a northwest to west-northwest prevailing wind direction. The average mean monthly
29 speed for 1945 to 1980 is 3.4 m/s (7.7 mph). Peak gust speeds range from 28 to 36 m/s
30 (63 to 80 mph) and are generally southwest or west-southwest winds (Stone et al. 1983).

32 Figure 3-7 shows wind roses for the Hanford Telemetry Network (Stone et al.
33 1983). The gravity drainage from the Cascades produces a prevailing west-northwest
34 wind in the 200 East Area. In July, hourly average wind speeds range from a low of 2.3
35 m/s (5.2 mph) from 9 to 10 a.m. to a high of 6 m/s (13.0 mph) from 9 to 10 p.m.

38 3.2.3 Temperature

40 Based on data from 1914 to 1980, minimum winter temperatures vary from -33
41 to -6°C (-27 to +22°F) and maximum summer temperatures vary from 38 to 46°C (100
42 to 115°F). Between 1914 and 1980, a total of 16 days with temperatures -29°C (-20°F)

or below are recorded. There are 10 days of record when the maximum temperature failed to go above -18°C (0°F). Prior to 1980 there were three summers on record when the temperatures were 38°C (100°F) or above for 11 consecutive days (Stone et al. 1983).

3.3 SURFACE HYDROLOGY

3.3.1 Regional Surface Hydrology

Surface drainage enters the Pasco Basin from several other basins, which include the Yakima River Basin, Walla Walla River Basin, Palouse/Snake Basin, and Big Bend Basin (Figure 3-8). Within the Pasco Basin, the Columbia River is joined by major tributaries including the Yakima, Snake, and Walla Walla Rivers. No perennial streams originate within the Pasco Basin. Columbia River inflow to the Pasco Basin is recorded at the United States Geological Survey (USGS) gage below Priest Rapids Dam and outflow is recorded below McNary Dam. Average annual flow at these recording stations is approximately $1.1 \times 10^{11} \text{ m}^3$ (8.7×10^7 acre-ft) at the USGS gage and $1.6 \times 10^{11} \text{ m}^3$ (1.3×10^8 acre-ft) at the McNary Dam gage (DOE 1988a).

Total estimated precipitation over the basin averages less than 16 cm/yr (6.3 in./yr). Mean annual runoff from the basin is estimated to be less than $3.1 \times 10^7 \text{ m}^3/\text{yr}$ (2.5×10^4 acre-ft/yr), or approximately 3% of the total precipitation. The remaining precipitation is assumed to be lost through evapotranspiration with a small component (perhaps less than 1%) recharging the groundwater system (DOE 1988a).

3.3.2 Surface Hydrology of the Hanford Site

Primary surface water features associated with the Hanford Site, located near the center of the Pasco Basin, are the Columbia and Yakima Rivers and their major tributaries, the Snake and Walla Walla Rivers. West Lake, about 4 hectares (10 acres) in size and less than 0.9 m (3 ft) deep, is the only natural lake within the Hanford Site (DOE 1988a). Wastewater ponds, cribs, and ditches associated with nuclear fuel reprocessing and waste disposal activities are also present on the Hanford Site.

The Columbia River flows through the northern part and along the eastern border of the Hanford Site. This section of the river, the Hanford Reach, extends from Priest Rapids Dam to the headwaters of Lake Wallula (the reservoir behind McNary Dam). Flow along the Hanford Reach is controlled by Priest Rapids Dam. Several drains and intakes are also present along this reach, including irrigation outfalls from the Columbia

1 Basin Irrigation Project, the Washington Public Power Supply System (WPPSS) Nuclear
2 Project 2, and Hanford Site intakes for on-site water use. Much of the northern and
3 eastern parts of the Hanford Site are drained by the Columbia River.

4
5 Routine water quality monitoring of the Columbia River is conducted by DOE for
6 both radiological and nonradiological parameters and has been reported by Pacific
7 Northwest Laboratory (PNL) since 1973. Ecology has issued a Class A (excellent) quality
8 designation for Columbia River water along the Hanford Reach from Grand Coulee
9 Dam, through the Pasco Basin, to McNary Dam. This designation requires that all
10 industrial uses of this water be compatible with other uses including drinking, wildlife
11 habitat, and recreation. In general, the Columbia River water is characterized by a very
12 low suspended load, a low nutrient content, and an absence of microbial contaminants
13 (DOE 1988a).

14
15 That portion of the Hanford Site not directly draining to the Columbia River is
16 drained by the Yakima River system. Cold Creek and its tributary, Dry Creek, are
17 ephemeral streams on the Hanford Site that are within the Yakima River drainage
18 system. Both streams drain areas along the western part of the Hanford Site and cross
19 the southwestern part of the Hanford Site toward the Yakima River. Surface flow, which
20 may occur during spring runoff or after heavier-than-normal precipitation, infiltrates and
21 disappears into the surface sediments. Rattlesnake Springs, located on the western part
22 of the Hanford Site, forms a small surface stream that flows for about 2.9 km (1.8 mi)
23 before infiltrating into the ground.

24 25 26 3.3.3 Semi-Works Aggregate Area Surface Hydrology

27
28 The Semi-Works Aggregate Area has no natural surface water bodies. The only
29 existing man-made surface water body is the 200 East Powerhouse Ditch located along
30 the southern boundary of the aggregate area. As discussed in Section 2, the ditch is 760
31 m (2,500 ft) long, 2.5 to 3.5 m (8 to 11.5 ft) deep, and approximately 6 m (20 ft) wide at
32 the bottom (DeFord 1992). The ditch receives cooling brines from batch processes and
33 boiler blowdown rinseate from the 200 East Power Plant. The flow rate from the
34 powerhouse facility to the ditch is estimated at 12,300,000 L/month (3,198,000 gal/month).
35 Ditch effluent is also dispersed by evaporation and infiltration to the soil column along
36 the ditch. Ditch effluent flows westward and is discharged to an approximately 76 cm (30
37 in) diameter corrugated metal pipe connected to the 216-B-3 Pond system.

38
39 In addition to the Powerhouse Ditch the Semi-Works Aggregate Area is the site of
40 the former 216-C-9 Pond, a 250 m by 30 m (800 ft by 100 ft) liquid waste disposal site
41 north of the former Semi-Works Complex (201-C Process Building). The 216-C-9 Pond,
42 which sits in a 7.5 m (25 ft) excavation, was divided into several lobes and filled to a

1 water depth of approximately 2 m (6.5 ft) with cooling water and other process waste
2 water from the 201-C Process Building. Discharge ceased in 1985 and a portion of the
3 pond was converted into a solid waste disposal site.

4
5 The 200 East Area, and specifically the Semi-Works Aggregate Area, is not in a
6 designated floodplain. Calculations of probable maximum floods for the Columbia River
7 and the Cold Creek Watershed indicate that the 200 East Area is not expected to be
8 inundated under maximum current flood conditions. Given the effluent volumes
9 conveyed, limited amount of precipitation, the Powerhouse Ditch dimensions, and the flat
10 nature of the surrounding topography, the potential for flooding in the Powerhouse Ditch
11 is low.

12 13 14 **3.4 GEOLOGY**

15
16 The following sections provide information pertaining to geologic characteristics of
17 southcentral Washington, the Hanford Site, the 200 East Area, and the Semi-Works
18 Aggregate Area. Topics included are the regional tectonic framework (Section 3.4.1),
19 regional stratigraphy (Section 3.4.2), and 200 East Area and Semi-Works Aggregate Area
20 geology (Section 3.4.3).

21
22 The geologic characterization of the Hanford Site, including the 200 East Area
23 and Semi-Works Aggregate Area is the result of many previous site investigation
24 activities at Hanford. These activities include the siting of nuclear reactors,
25 characterization activities for BWIP, waste management activities, and related geologic
26 studies supporting these efforts. Geologic investigations have included regional and
27 Hanford Site surface mapping, borehole/well sediment logging, field and laboratory
28 sediment classification, borehole geophysical studies (including gamma radiation logging),
29 and in situ and laboratory hydrogeologic properties testing.

30 31 32 **3.4.1 Regional Tectonic Framework**

33
34 The following sections provide information on regional (southcentral Washington)
35 geologic structure, structural geology of the Pasco Basin and the Hanford Site, and
36 regional and Hanford Site seismology.

37
38 **3.4.1.1 Regional Geologic Structure.** The Columbia Plateau is a part of the North
39 American continental plate and lies in a back-arc setting east of the Cascade Range. It is
40 bounded on the north by the Okanogan Highlands, on the east by the Northern Rocky
41 Mountains and Idaho Batholith, and on the south by the High Lava Plains and Snake
42 River Plain (Figure 3-9).

1 The Columbia Plateau can be divided into three informal structural subprovinces
2 (Figure 3-10): Blue Mountains, Palouse, and Yakima Fold Belt (Tolan and Reidel 1989).
3 These structural subprovinces are delineated on the basis of their structural fabric, unlike
4 the physiographic provinces that are defined on the basis of landforms. The Hanford
5 Site is located in the Yakima Fold Belt Subprovince near its junction with the Palouse
6 Subprovinces.

7
8 The principal characteristics of the Yakima Fold Belt (Figure 3-11) are a series of
9 segmented, narrow, asymmetric anticlines that have wavelengths between 5 and 31 km (3
10 and 19 mi) and amplitudes commonly less than 1 km (0.6 mi) (Reidel et al. 1989a). The
11 northern limbs of the anticlines generally dip steeply to the north, are vertical, or even
12 overturned. The southern limbs generally dip at relatively shallow angles to the south.
13 Thrust or high-angle reverse faults with fault planes that strike parallel or subparallel to
14 the axial trends are principally found on the north sides of these anticlines. The amount
15 of vertical stratigraphy offset associated with these faults varies but commonly exceeds
16 hundreds of meters. These anticlinal ridges are separated by broad synclines or basins
17 that, in many cases, contain thick accumulations of Neogene- to Quaternary-age
18 sediments. The Pasco Basin is one of the larger structural basins in the Yakima Fold
19 Belt Subprovince.

20
21 Deformation of the Yakima folds occurred under a north-south compression and
22 was contemporaneous with the eruption of the basalt flows (Reidel 1984; Reidel et al.
23 1989a). Deformation occurred during the eruption of the Columbia River Basalt Group
24 and continued through the Pliocene Epoch, into the Pleistocene Epoch, and perhaps to
25 the present.

26
27 **3.4.1.2 Pasco Basin and Hanford Site Structural Geology.** The Pasco Basin, in which
28 the Hanford Site is located, is bounded on the north by the Saddle Mountains anticline,
29 on the west by the Umtanum Ridge, Yakima Ridge, and Rattlesnake Hills anticlines, on
30 the south by the Rattlesnake Mountain anticline, and to the east by the Jackass
31 Monocline (Figure 3-12). The Pasco Basin is divided into the Wahluke syncline on the
32 north, and Cold Creek syncline on the south, by the Gable Mountain anticline, the
33 easternmost extension of the Umtanum Ridge anticline. The Cold Creek syncline is
34 bounded on the south by the Yakima Ridge anticline. Both the Cold Creek and
35 Wahluke synclines are asymmetric and relatively flat-bottomed structures. The north
36 limbs of both synclines dip gently (approximately 5°) to the south and the south limbs dip
37 steeply to the north. The deepest parts of the Cold Creek syncline, the Wye Barricade
38 depression, and the Cold Creek depression are approximately 12 km (7.5 mi) southeast
39 of the Hanford Site 200 Areas, and to the west-southwest of the 200 East Area,
40 respectively. The deepest part of the Wahluke syncline lies just north of Gable Gap.

1 The 200 East Area is situated on the generally southward dipping north limb of
2 the Cold Creek syncline 1 to 5 km (0.6 to 3 mi) north of the syncline axis. The Gable
3 Mountain-Gable Butte segment of the Umtanum Ridge anticline lies approximately 4 km
4 (2.5 mi) north of the 200 West Area. The axes of the anticline and syncline are
5 separated by a distance of 9 to 10 km (5.6 to 6.2 mi) and the crest of the anticline (as
6 now exposed) is over 200 m (656 ft) higher than the uppermost basalt layer in the
7 syncline axis. As a result, the basalts and overlying sediments dip to the south and
8 southwest beneath the 200 East Area.

9
10 **3.4.1.3 Regional and Hanford Site Seismology.** Eastern Washington, especially the
11 Columbia Plateau region, is a seismically inactive area when compared to the rest of the
12 western United States (DOE 1988a). The historic seismic record for eastern Washington
13 began in approximately 1850, and no earthquakes large enough to be felt had epicenters
14 on the Hanford Site. The closest regions of historic moderate-to-large earthquake
15 generation are in western Washington and Oregon and western Montana and eastern
16 Idaho. The most significant event relative to the Hanford Site is the 1936 Milton-
17 Freewater, Oregon, earthquake that had a magnitude of 5.75 and that occurred more
18 than 90 km (54 mi) away. The largest Modified Mercalli Intensity for this event was felt
19 about 105 km (63 mi) from the Hanford site at Walla Walla, Washington, and was VII.

20
21 Geologic evidence of past moderate or possibly large earthquake activity is shown
22 by the anticlinal folds and faulting associated with Rattlesnake Mountain, Saddle
23 Mountain, and Gable Mountain. The currently recorded seismic activity related to these
24 structures consists of micro-size earthquakes. The suggested recurrence rates of
25 moderate and larger-size earthquakes on and near the Hanford Site are measured in
26 geologic time (tens of thousands of years) (DOE 1988).

27 28 29 **3.4.2 Regional Stratigraphy**

30
31 The following sections summarize regional stratigraphic characteristics of the
32 Columbia River Basalt and Suprabasalt sediments. Specific references to the Hanford
33 Site and 200 East Area are made where applicable to describe the general occurrence of
34 these units within the Pasco Basin.

35
36 The principal geologic units within the Pasco Basin include the Miocene age basalt
37 of the Columbia River Basalt Group, and overlying late Miocene to Pleistocene
38 suprabasalt sediments (Figure 3-13). Older Cenozoic sedimentary and volcanoclastic
39 rocks underlying the basalts are not exposed at the surface near the Hanford Site. The
40 basalts and sediments thicken into the Pasco Basin and generally reach maximum
41 thicknesses in the Cold Creek syncline. The sedimentary sequence at the Hanford Site is
42 up to approximately 230 m (750 ft) thick in the west-central Cold Creek syncline, but

1 pinches out against the anticlinal structures of Saddle Mountains, Gable
2 Mountain/Umtanum Ridge, Yakima Ridge, and Rattlesnake Hills.

3
4 The suprabasalt sediment sequence is up to approximately 230 m (750 ft) thick
5 and dominated by laterally extensive deposits assigned to the late Miocene- to Pliocene-
6 age Ringold Formation and the Pleistocene-age Hanford formation (Figure 3-13).
7 Locally occurring strata informally referred to as the pre-Missoula gravels, Plio-
8 Pleistocene unit, and early "Palouse" soil comprise the remainder of the sedimentary
9 sequence. The pre-Missoula gravels underlie the Hanford formation in the east-central
10 Cold Creek syncline and at the east end of Gable Mountain anticline east and south of
11 200 East Area. The pre-Missoula gravels have not been identified in the 200 East Area.
12 The nature of the contact between the pre-Missoula gravels and the overlying Hanford
13 formation has not been completely delineated. In addition, it is unclear whether the pre-
14 Missoula gravels overlie or interfinger with the early "Palouse" soil and Plio-Pleistocene
15 unit. Magnetic polarity data indicate the unit is no younger than early Pleistocene in age
16 (>1 Ma) as discussed in Baker et al. (1991).

17
18 Relatively thin surficial deposits of eolian sand, loess, alluvium, and colluvium
19 discontinuously overlie the Hanford formation.

20
21 **3.4.2.1 Columbia River Basalt Group.** The Columbia River Basalt Group (Figure 3-13)
22 comprises an assemblage of tholeiitic, continental flood basalts of Miocene age. These
23 flows cover an area of more 163,000 km² (63,000 mi²) in Washington, Oregon, and Idaho
24 and have an estimated volume of about 174,000 km³ (40,800 mi³) (Tolan et al. 1989).
25 Isotopic age determinations indicate that basalt flows were erupted approximately 17 to 6
26 Ma (million years before present), with more than 98% by volume being erupted in a 2.5
27 million year period (17 to 14.5 Ma) (Reidel et al. 1989b).

28
29 Columbia River basalt flows were erupted from north-northwest-trending fissures
30 of linear vent systems in north-central and northeastern Oregon, eastern Washington, and
31 western Idaho (Swanson et al. 1979). The Columbia River Basalt Group is formally
32 divided into five formations (from oldest to youngest): Imnaha Basalt, Picture Gorge
33 Basalt, Grande Ronde Basalt, Wanapum Basalt, and Saddle Mountains Basalt. Of these,
34 only the Picture Gorge Basalt is not known to be present in the Pasco Basin. The Saddle
35 Mountains Basalt, divided into the Ice Harbor, Elephant Mountain, Pomona, Esquatzel,
36 Asotin, Wilbur Creek, and Umatilla Members (Figure 3-13), forms the uppermost basalt
37 unit throughout most of the Pasco Basin. The Elephant Mountain Member is the
38 uppermost unit beneath most of the Hanford Site except near the 300 Area where the
39 Ice Harbor member is found and north of the 200 Areas where the Saddle Mountains
40 Basalt is locally absent and the Umatilla Member exposed. On anticlinal ridges bounding
41 the Pasco Basin, the Saddle Mountains Basalt is frequently absent, exposing the
42 Wanapum and Grande Ronde Basalts.

3.4.2.2 Ellensburg Formation. The Ellensburg Formation consists of all sedimentary units that occur between the basalt flows of the Columbia River Basalt Group in the central Columbia Basin. The Ellensburg Formation generally displays two main lithologies: volcanoclastics, and siliciclastics. The volcanoclastics consist mainly of primary pyroclastic air fall deposits and reworked epiclastics derived from volcanic terrains west of the Columbia Plateau. Siliciclastic strata in the Ellensburg Formation consists of clastic, plutonic, and metamorphic detritus derived from the Rocky Mountain terrain. Both volcanoclastic and siliciclastic lithologies occur both distinctly and interfingered in the Pasco Basin. A detailed discussion of the Ellensburg Formation at the Hanford Site is given by Reidel and Fecht (1981). Smith et al. (1989) provide a discussion of age equivalent units adjacent to the Columbia Plateau.

The stratigraphic names for individual units of the Ellensburg Formation are given on Figure 3-13. The nomenclature for these units is based on the upper- and lower-bounding basalt flows and thus the names are valid only for those areas where the bounding basalt flows occur. Because the Pasco Basin is an area where most bounding flows occur, the names given on Figure 3-13 are applicable to the Hanford Site. At the Hanford Site the three uppermost units of the Ellensburg Formation are the Selah interbed, the Rattlesnake Ridge interbed, and the Levey interbed.

3.4.2.2.1 Selah Interbed. The Selah interbed is bounded on the top by the Pomona member and on the bottom by the Esquatzel member. The interbed is a variable mixture of silty to sandy vitric tuff, arkosic sands, tuffaceous clays, and locally thin stringers of predominantly basaltic gravels. The Selah interbed is found beneath most of the Hanford Site.

3.4.2.2.2 Rattlesnake Ridge Interbed. The Rattlesnake Ridge interbed is bounded on the top by the Elephant Mountain member and on the bottom by the Pomona member. The interbed is up to 33 m (108 ft) thick and dominated by three facies at the Hanford Site: 1) a lower clay or tuffaceous sandstone, 2) a middle, micaceous-arkosic and/or tuffaceous sandstone, and 3) an upper, tuffaceous siltstone to sandstone. The unit is found beneath most of the Hanford Site.

3.4.2.2.3 Levey Interbed. The Levey interbed is the uppermost unit of the Ellensburg Formation and occurs between the Ice Harbor member and the Elephant Mountain member. It is confined to the vicinity of the 300 Area. The Levey interbed is a tuffaceous sandstone along its northern edge and a fine-grained tuffaceous siltstone to sandstone along its western and southern margins.

3.4.2.3 Ringold Formation. The Ringold Formation at the Hanford Site is up to 185 m (607 ft) thick in the deepest part of the Cold Creek syncline south of the 200 West Area and 170 m (558 ft) thick in the western Wahluke syncline near the 100-B Area. The

Ringold Formation pinches out against the Gable Mountain, Yakima Ridge, Saddle Mountains, and Rattlesnake Mountain anticlines. It is largely absent in the northern and northeastern parts of the 200 East Area and adjacent areas to the north in the vicinity of Gable Gap. The Ringold Formation is assigned a late Miocene to Pliocene age (Fecht 1978; DOE 1988b) and was deposited in alluvial and lacustrine environments (Bjornstad 1985; Fecht et al. 1987; Lindsey 1991a).

Recent studies of the Ringold Formation (Lindsey and Gaylord 1989 and Lindsey et al. 1992) indicate that it is best described and divided on the basis of sediment facies associations and their distribution. Facies associations in the Ringold Formation (defined on the basis of lithology, petrology, stratification, and pedogenic alteration) include fluvial gravel, fluvial sand, overbank deposits, lacustrine deposits, and alluvial fan. The facies associations are summarized as follows:

- Fluvial gravel—Clast-supported granule to cobble gravel with a sandy matrix dominates the association. Intercalated sands and muds also are found. Clast composition is very variable, with common types being basalt, quartzite, porphyritic volcanics, and greenstones. Silicic plutonic rocks, gneisses, and volcanic breccias also are found. Sands in this association are generally quartzo-feldspathic, with basalt contents generally in the range of 5 to 25%. Low angle to planar stratification, massive channels, and large-scale cross-bedding are found in outcrops. The association was deposited in a gravelly fluvial system characterized by wide, shallow shifting channels.
- Fluvial sand—Quartzo-feldspathic sands displaying cross-bedding and cross-lamination in outcrop dominate this association. These sands usually contain less than 15% basalt lithic fragments, although basalt contents as high as 50% may be encountered. Intercalated strata consist of lenticular silty sands and clays up to 3 m (10 ft) thick and thin (<0.5 m [<1.5 ft]) gravels. Fining upwards sequences less than 1 m (3.3 ft) to several meters thick are common in the association. Strata comprising the association were deposited in wide, shallow channels.
- Overbank deposits—This association dominantly consists of laminated to massive silt, silty fine-grained sand, and paleosols containing variable amounts of pedogenic calcium carbonate. Overbank deposits occur as thin lenticular interbeds (<0.5 m to 2 m, <1.6 ft to 6 ft) in the fluvial gravel and fluvial sand associations and as thick (up to 10 m, 3 ft) laterally continuous sequences. These sediments record deposition in a floodplain under proximal levee to more distal floodplain conditions.
- Lacustrine—Plane laminated to massive clay with thin silt and silty sand interbeds displaying some soft-sediment deformation characterize this association.

Coarsening upwards packages less than 1 m (3.3 ft) to 10 m (33 ft) thick are common in the association. Strata comprising the association were deposited in a lake under standing water to deltaic conditions.

- Alluvial fan—Massive to crudely stratified, weathered to unweathered basaltic detritus dominates this association. These basaltic deposits generally are found around the periphery of the basin. This association was deposited largely by debris flows in alluvial fan settings.

The lower half of the Ringold Formation contains five separate stratigraphic intervals dominated by fluvial gravels. These gravels, designated units A, B, C, D, and E (Figure 3-14), are separated by intervals containing deposits typical of the overbank and lacustrine facies associations. The lowermost of the fine-grained sequences, overlying unit A, is designated the lower mud sequence. The uppermost gravel unit, unit E, grades upward into interbedded fluvial sand and overbank deposits. These sands and overbank deposits are overlain by lacustrine-dominated strata.

Fluvial gravel units A and E correspond to the lower basal and middle Ringold units, respectively, as defined by DOE (1988). Gravel units B, C, and D do not correlate to any previously defined units. The lower mud sequence corresponds to the upper basal and lower units as defined by DOE (1988). The upper basal and lower units are not differentiated. The sequence of fluvial sands, overbank deposits, and lacustrine sediments overlying unit E corresponds to the upper unit as seen along the White Bluffs in the eastern Pasco Basin. This essentially is the same usage as originally proposed by Newcomb (1958) and Myers et al. (1979).

3.4.2.4 Plio-Pleistocene Unit. Unconformably overlying the Ringold Formation in the western Cold Creek syncline in the vicinity of 200 West Area (Figures 3-12, 3-13, and 3-14) is the laterally discontinuous Plio-Pleistocene unit (DOE 1988a). The unit is up to 25 m (82 ft) thick and divided into two facies: (1) sidestream alluvium and (2) calcic paleosol (Stage III and Stage IV) (Bjornstad 1984; DOE 1988b). The calcic paleosol facies consist of massive calcium carbonate-cemented silt, sand, and gravel (caliche) to interbedded caliche-rich and caliche-poor silts and sands. The basaltic detritus facies consists of weathered and unweathered basaltic gravels deposited as locally derived slope wash, colluvium, and sidestream alluvium. Where the unit occurs, it unconformably overlies the Ringold Formation. The Plio-Pleistocene unit appears to be correlative to other sidestream alluvial and pedogenic deposits found near the base of the ridges bounding the Pasco Basin on the north, west, and south. These sidestream alluvial and pedogenic deposits are inferred to have a late Pliocene to early Pleistocene age on the basis of stratigraphic position and magnetic polarity of interfingering loess units.

1 **3.4.2.5 Pre-Missoula Gravels.** Quartzose to gneissic clast-supported pebble to cobble
2 gravel with a quartzo-feldspathic sand matrix underlies the Hanford formation in the
3 east-central Cold Creek syncline and at the east end of Gable Mountain anticline east
4 and south of the 200 East Area (Figures 3-12, 3-13, and 3-14). These gravels, called the
5 pre-Missoula gravels (PSPL 1982), are up to 25 m (82 ft) thick, contain less basalt than
6 underlying Ringold gravels and overlying Hanford deposits, have a distinctive white or
7 bleached color, and sharply truncate underlying strata. The nature of the contact
8 between the pre-Missoula gravels and the overlying Hanford formation is not clear. In
9 addition, it is unclear whether the pre-Missoula gravels overlie or interfinger with the
10 early "Palouse" soil and Plio-Pleistocene unit. Magnetic polarity data indicate the unit is
11 no younger than early Pleistocene in age (>1 Ma) (Baker et al. 1991).

12
13 **3.4.2.6 Early "Palouse" Soil.** The early "Palouse" soil consists of up to 20 m (66 ft) of
14 massive, brown yellow, and compact, loess-like silt and minor fine-grained sand (Tallman
15 et al. 1981; DOE 1988a). These deposits overlie the Plio-Pleistocene unit in the western
16 Cold Creek syncline around the 200 West Area (Figures 3-12, 3-13, and 3-14). The unit
17 is differentiated from overlying graded rhythmite (Hanford formation) by greater
18 calcium carbonate content, massive structure in core, and high natural gamma response
19 in geophysical logs (Bjornstad 1984 and DOE 1988a). The upper contact of the unit is
20 poorly defined, and it may grade up-section into the lower part of the Hanford
21 formation. Based on a predominantly reversed polarity the unit is inferred to be early
22 Pleistocene in age (Baker et al. 1991).

23
24 **3.4.2.7 Hanford Formation.** The Hanford formation consists of pebble to boulder
25 gravel, fine- to coarse-grained sand, and silt (Baker et al. 1991). These deposits are
26 divided into three facies: (1) gravel-dominated, (2) sand-dominated, and (3) silt-
27 dominated facies. These facies are referred to as coarse-grained deposits, plane-
28 laminated sand facies, and rhythmite facies, respectively, in Baker et al. (1991). The silt-
29 dominated facies also is referred to as slackwater deposits or Touchet Beds, while the
30 gravelly facies are generally referred to as the Pasco Gravels. The Hanford formation is
31 thickest in the Cold Creek bar in the vicinity of 200 West and 200 East Areas where it is
32 up to 107 m (350 ft) thick (Figures 3-12, 3-13, and 3-14). The Hanford formation was
33 deposited by cataclysmic flood waters that drained out of glacial Lake Missoula (Fecht et
34 al. 1987; DOE 1988b; and Baker et al. 1991). Hanford deposits are absent on ridges
35 above approximately 385 m (1,263 ft) above sea level. The following sections describe
36 the three Hanford formation facies.

37
38 **3.4.2.7.1 Gravel-Dominated Facies.** The gravel-dominated facies is dominated by
39 coarse-grained sand and granule to boulder gravel. These deposits display massive
40 bedding, plane to low-angle bedding, and large-scale cross-bedding in outcrop, while the
41 gravels generally are matrix-poor and display an open-framework texture. Lenticular
42 sand and silt beds are intercalated throughout the facies. Gravel clasts in the facies

generally are dominated by basalt (50 to 80%). Other clast types include Ringold and Plio-Pleistocene rip-ups, granite, quartzite, and gneiss clasts. The relative proportion of gneissic and granitic clasts in Hanford gravels versus Ringold gravels generally is higher (up to 20% as compared to less than 5%). Sands in this facies usually are very basaltic (up to 90%), especially in the granule size range. Locally Ringold and Plio-Pleistocene rip-up clasts dominate the facies comprising up to 75% of the deposit. The gravel facies dominates the Hanford formation in the 100 Areas north of Gable Mountain, the northern part of 200 East Area, and the eastern part of the Hanford Site including the 300 Area. The gravel-dominated facies was deposited by high-energy flood waters in or immediately adjacent to the main cataclysmic flood channelways.

3.4.2.7.2 Sand-Dominated Facies. The sand-dominated facies consists of fine-grained to granular sand displaying plane lamination and bedding and less commonly plane cross-bedding in outcrop. These sands may contain small pebbles in addition to pebble-gravel interbeds and silty interbeds less than 1 m (3.3 ft) thick. The silt content of these sands is variable, but where it is low, an open framework texture is common. These sands are typically very basaltic, commonly being referred to as black or gray or salt and pepper sands. This facies is most common in the central Cold Creek syncline, in the central to southern parts of the 200 East and 200 West Areas, and in the vicinity of the WPPSS facilities. The sand-dominated facies was deposited in channelways as flow power waned and adjacent to main flood channelways as water in the channelways spilled out of them, losing their competence. The facies is transitional between gravel-dominated facies and silt-dominated facies.

3.4.2.7.3 Silt-dominated Facies. The silt-dominated (slackwater) facies consists of thinly bedded, plane-laminated and ripple cross-laminated silt and fine- to coarse-grained sand that commonly display normally graded rhythmites similar to Bouma sequences, a few centimeters to several tens of centimeters thick in outcrop (Myers et al. 1979; DOE 1988b; Baker et al. 1991). The facies dominates the Hanford formation throughout the central, southern, and western Cold Creek syncline within and south of 200 East and West Areas. These sediments were deposited under slackwater conditions and in backflooded areas (DOE 1988b).

3.4.2.8 Holocene Surficial Deposits. Holocene surficial deposits consist of silt, sand, and gravel that form a thin (<10 m, 33 ft) veneer across much of the Hanford Site. These sediments were deposited by a mix of eolian and alluvial processes.

3.4.3 200 East Area and Semi-Works Aggregate Area Geology

The following sections describe the occurrence and variation of suprabasalt sediments in the 200 East Area. The sections discuss notable stratigraphic characteristics,

1 sediment thickness variations, dip trends, and other features such as areas where
2 sediments are known or suspected to be absent. Also, stratigraphic variations pertinent
3 to the Semi-Works Aggregate Area are identified where applicable, and are presented in
4 the overall context of stratigraphic trends throughout the 200 East Area. The following
5 text sections are based extensively on Lindsey et al. (1992).
6

7 Geologic cross sections depicting the distribution of basalt and sedimentary units
8 within and near the Semi-Works Aggregate Area are presented on Figures 3-17 and 3-18.
9 Figure 3-15 illustrates the cross sections locations. A legend for symbols used on the
10 cross sections is provided on Figure 3-16. The Figure 3-17 cross section (A-A') was
11 constructed from geologic information from the three groundwater monitoring well logs
12 and logs from other vadose zone soil borings in the Semi-Works Aggregate Area
13 (Chamness et al. 1992). The Figure 3-18 cross section is taken directly from Lindsey et
14 al. (1992). The geologic cross sections show the location of the Semi-Works Aggregate
15 Area. Figures 3-19 through 3-32 are taken from Lindsey et al. (1992) and present
16 isopach and structure contour data for suprabasalt sedimentary units in the 200 East
17 Area and Semi-Works Aggregate Area.
18

19 **3.4.3.1 Ellensburg Formation.** The Rattlesnake Ridge interbed of the Ellensburg
20 Formation is found beneath the entire 200 East Area (Reidel and Fecht 1981). Mapping
21 on Gable Mountain indicates it is absent at many localities on this structural high and in
22 some areas near Gable Mountain Pond (Fecht 1978). Three units comprise the
23 Rattlesnake Ridge interbed; 1) a lower clay or tuffaceous sandstone, 2) a middle,
24 micaceous-arkosic and/or tuffaceous sandstone, and 3) an upper, tuffaceous siltstone or
25 sandstone. In the 200 Area East, the unit thickens from 6 m (20 ft) in the north to
26 approximately 26 m (80 ft) in the south. The upper contact of the interbed with the
27 overlying Elephant Mountain Member generally is baked from contact with the basalt
28 (Fecht 1978).
29

30 **3.4.3.2 Elephant Mountain Member.** The uppermost basalt unit beneath most of the
31 200 East Aggregate Area is the Elephant Mountain Member of the Saddle Mountains
32 Basalt (Figure 3-19). Like the Rattlesnake Ridge interbed of the Ellensburg Formation,
33 the Elephant Mountain basalt is absent due to erosion in the Gable Gap area (Myers
34 and Price 1981 - Figure 8-26). Southeast of Gable Gap the Elephant Mountain Member
35 is locally absent due to erosion in two areas of uncertain lateral extent. These are found
36 near the West Lake area and in the northeast corner of the 200 East Area (Graham et
37 al. 1984). In these areas the uppermost basalt encountered is the Pomona Member.
38 Where the Elephant Mountain Member is absent the Rattlesnake Ridge interbed, the
39 sedimentary unit that separates the Elephant Mountain and Pomona Members, is
40 encountered above the first basalt unit. In the Semi-Works Aggregate Area, the
41 Elephant Mountain Member is generally around 115 m (380 ft) below land surface and
42 dips gently southwest.

1 **3.4.3.3 Ringold Formation.** Within the 200 East Area, the Ringold Formation includes
2 the fluvial gravels of unit A, the muds of the lower mud unit, and the Fluvial Gravels of
3 unit E. Ringold units B, C, D, and the Upper Ringold are not found in the immediate
4 vicinity of the 200 East Area.

5
6 The lowest Ringold unit in the 200 East Area, the fluvial gravels of unit A, thicken
7 and dip to the south and southwest toward the axis of the Cold Creek syncline. Unit A
8 generally pinches out in the central part of the area against structural highs in the
9 underlying basalt. Thin, lenticular occurrences of unit A are found locally in the area
10 between the northeast 200 East Area and Gable Mountain. Most of the Ringold gravels
11 encountered in the central part of the 200 East Area probably belong to unit A (Lindsey
12 et al. 1992). The top of the unit is a relatively flat surface that dips to the south into the
13 Cold Creek syncline. Intercalated lenticular sand and silt of the fluvial sand and
14 overbank facies associations are found locally in the middle part of the unit in the
15 southeastern part of the area. The Ringold unit A is present throughout the Semi-Works
16 Aggregate Area (Figures 3-20 and 3-21). Unit A ranges in thickness from approximately
17 31 m (100 ft) in the southwest corner of the Semi-Works Aggregate Area to
18 approximately 9 m (28 ft) in the northeast corner of the Semi-Works Aggregate Area.

19
20 The overbank and lacustrine deposits of the lower mud sequence thicken and dip
21 to the south and southwest in a manner similar to the Ringold unit A gravels (Figure
22 3-22). However, unlike unit A, the line along which the lower mud sequence pinches out
23 is very irregular (Figure 3-23). In the area between the 200 East Area and Gable
24 Mountain the lower mud sequence can be found directly overlying the Elephant
25 Mountain basalt at a number of locations where unit A is absent. Within the central part
26 of the 200 East Area the lower mud sequence is largely absent. The nature of the
27 pinchout of the lower mud sequence varies from location to location. At some locations
28 it pinches out against uplifted basalt while at other locations the sequence is truncated by
29 overlying deposits (either Ringold gravel unit E or Hanford gravels). In the area
30 between Gable Mountain and the 200 East Area and in the vicinity of the 216-B-3 Pond
31 complex, the lower mud sequence forms the uppermost part of the Ringold Formation
32 and is overlain by the Hanford formation. Throughout the rest of the 200 East Area the
33 lower mud sequence is overlain by the gravels of Ringold unit E. In the Semi-Works
34 Aggregate Area the lower mud unit is probably not present, and has not been identified
35 from the well logs reviewed.

36
37 Ringold unit E thickens to the south and southwest in the 200 East Area (Figure
38 3-24). Like the lower mud sequence, the line along which unit E pinches out is very
39 irregular (Figure 3-25). In the 200 East Area, unit E is largely restricted to the southwest
40 corner of the area and the GTR. It is absent in the B Pond area, the central and
41 northern part of the area, and from the area between 200 East and Gable Mountain.
42 Based on the stratigraphic relationships shown on Figure 3-13, most of the Ringold

1 gravels encountered beneath the central part of the 200 East Area are part of gravel unit
2 A and not gravel unit E. Ringold unit E dominantly consists of fluvial gravels. Strata
3 typical of the fluvial sand and overbank facies associations may be encountered locally.
4 However, predicting where intercalated lithologies will occur is very difficult. In the
5 Semi-Works Aggregate Area the Ringold unit E is not present except in the southeast
6 corner where it ranges in thickness from 0 to approximately 7.5 m (25 ft). A structure
7 map depicting the top of the Ringold Formation is presented on Figure 3-26.

8
9 **3.4.3.4 Plio-Pleistocene Unit and Early "Palouse" Soil.** The Plio-Pleistocene unit and
10 early "Palouse" soil are not found within or near the 200 East Area or the Semi-Works
11 Aggregate Area. They are encountered only in the vicinity of the 200 West Area
12 approximately 5 km (3 mi) west of the 200 East Area.

13
14 **3.4.3.5 Hanford Formation.** As discussed in the regional geology section, the cataclysmic
15 flood deposits of the Hanford formation are divided into three facies: 1) gravel-
16 dominated, 2) sand-dominated, and 3) the slackwater facies. Typical lithologic
17 successions consist of fining upwards packages, major fine-grained intervals, and laterally
18 persistent coarse-grained sequences. Mineralogic and geochemical data were not used in
19 differentiating units because of the lack of a comprehensive mineralogic and geochemical
20 data set. Studying the distribution of these facies types and identifying similarities in
21 lithologic succession from borehole to borehole across the 200 East Area indicates the
22 Hanford formation can be divided into three stratigraphic sequences. However, because
23 of the variability of Hanford deposits, definition of these sequences is arbitrary and
24 contacts between them can be very gradational.

25
26 Three stratigraphic sequences composed mostly of the gravel-dominated and sand-
27 dominated facies are defined in the Hanford formation. Two of the sequences are
28 dominated by deposits typical of the gravel-dominated facies and they are designated the
29 upper and lower gravel sequences. The third sequence consists of deposits of the sand-
30 dominated facies with lesser intercalated occurrences from both the gravel-dominated
31 and slackwater facies. This sequence, designated the sandy sequence, generally is
32 situated between the upper and lower gravel sequences.

33
34 The lower gravel sequence is dominated by deposits typical of the gravel-
35 dominated facies. Local intercalated intervals of the sand-dominated facies are also
36 found. The lower gravel sequence ranges from 0 to 44 m (0 to 135 ft) thick and is found
37 throughout most of the 200 East Area (Figures 3-27 and 3-28). The sequence probably
38 is present in these areas, but because of the absence of the fine sequence that separates
39 the lower from the upper coarse sequences it is impossible to determine the true extent
40 of the lower coarse sequence. The contact between the lower coarse sequence and the
41 overlying sandy sequence is arbitrarily placed at the top of the first thick (> 6 m, >20

ft]) gravel interval encountered below the sand-dominated strata of the sandy sequence. The lower gravel sequence is not present in the Semi-Works Aggregate Area.

The sandy sequence consists of a heterogenous mix of sands typical of the sand-dominated facies. Silts typical of the slackwater facies are present, but less abundant. The sandy sequence ranges from 0 to 92 m (0 to 280 ft) thick (Figures 3-29 and 3-30). This sequence is dominated by the sand-dominated facies in the north, and the slackwater facies toward the south. Gravels, occurring both singly and as interbeds are common in the sandy sequence, especially toward the north. Thin intervals typical of the gravel facies also are encountered. The sandy sequence probably contains the greatest concentration of clastic dikes and it is laterally equivalent with lower fine sequence in the 200 West Area (Lindsey et al. 1991). Where the sandy sequence pinches out it commonly interfingers with gravels of the overlying and underlying gravel sequences. Where this occurs the contact separating the sandy sequence from the other intervals is arbitrary. The sandy sequence is differentiated from the gravelly strata of the upper and lower gravel sequences on the basis of sand content. The base of the sandy sequence is placed at the top of the highest gravelly interval and underlies sand-dominated strata. The top of the sequence is placed at the top of the highest thick, sand-dominated interval. In the Semi-Works Aggregate Area the sandy sequence ranges in thickness from 86 m (282 ft) in the southwest to approximately 60 m (197 ft) in the northeast corner (Figures 3-29 and 3-30) and generally thickens to the southwest.

The third Hanford formation stratigraphic sequence consists of gravel-dominated strata referred to as the upper coarse gravel sequence. This sequence is dominated by deposits typical of the gravel-dominated facies. Lesser occurrences of the sand-dominated facies are encountered locally. The sequence thins from as much as 60 m (197 ft) in the north to zero near the southern border of the 200 East Area (Figures 3-31). In addition, at one location, northwest of the 200 East Area, the sequence thins more than surrounding localities and at another location, in the central part of the 200 East Area, the unit is completely absent. Where the upper gravel sequence is thickest, in the north, it is found to form an elongated northwest to southeast oriented body. The upper coarse and lower coarse sequences are not differentiated in this area where the intervening sandy sequence is absent. Figure 3-32 depicts variations in thickness of the Hanford formation throughout the 200 East Area. In the Semi-Works Aggregate Area the upper coarse gravel sequence is locally absent (Figure 3-31) or forms a thin sheet (<4 m [<13 ft]) around the perimeter of the Semi-Works Aggregate Area.

3.4.3.6 Holocene Surficial Deposits. Holocene-age surficial deposits in the 200 East Area are dominated by fine- to medium-grained to occasionally silty eolian sands. These deposits have been removed from much of the area by construction activities. Where the eolian sands are found they tend to consist of thin (<3 m [<10 ft]) sheets that cover the ground. Dunes are not generally well developed within the 200 East Area. Holocene

1 surficial deposits are found in thin sheets (± 5 m [± 16 ft]) covering parts of the Semi-
2 Works Aggregate Area (Lindsey et al. 1992 geologic log of well 299-E28-4).

3.5 HYDROGEOLOGY

3
4
5
6
7 The following sections present discussions of regional hydrogeology (Section 3.5.1),
8 Hanford Site hydrogeology (3.5.2), and Semi-Works Aggregate Area hydrogeology
9 (Section 3.5.3). Sections 3.5.2 and 3.5.3 also discuss Hanford Site and Semi-Works
10 Aggregate Area vadose zone characteristics.

3.5.1 Regional Hydrogeology

11
12
13
14
15 The hydrogeology of the Pasco Basin is characterized by a multiaquifer system
16 that consists of four hydrogeological units that correspond to the upper three formations
17 of the Columbia River Basalt Group (Grande Ronde Basalt, Wanapum Basalt, and
18 Saddle Mountains Basalt) and the suprabasalt sediments. The basalt aquifers consist of
19 the tholeiitic flood basalts of the Columbia River Basalt Group and relatively minor
20 amounts of intercalated fluvial and volcanoclastic sediments of the Ellensburg Formation.
21 Confined zones in the basalt aquifers are present in the sedimentary interbeds and/or
22 interflow zones that occur between dense basalt flows. The main water-bearing portions
23 of the interflow zones are networks of interconnecting vesicles and fractures of the flow
24 tops and flow bottoms (DOE 1988a). The suprabasalt sediment or uppermost aquifer
25 system consists of fluvial, lacustrine, and glaciofluvial sediments. This aquifer is regionally
26 unconfined and is contained largely within the Ringold Formation and Hanford
27 formation. The position of the water table in the southwest Pasco Basin is generally
28 within the Ringold fluvial gravels of unit E. In the northern and eastern Pasco Basin the
29 water table is generally within the Hanford formation. Table 3-1 presents hydraulic
30 parameters for various water-bearing geologic units at the Hanford Site.

31
32 Local recharge to the shallow basalt aquifers results from infiltration of
33 precipitation and runoff along the margins of the Pasco Basin, and in areas of artificial
34 recharge where a downward gradient from the unconfined aquifer systems to the
35 uppermost confined basalt aquifer may occur. Regional recharge of the deep basalt
36 aquifers is inferred to result from interbasin groundwater movement originating northeast
37 and northwest of the Pasco Basin in areas where the Wanapum and Grande Ronde
38 Basalts crop out extensively (DOE 1988a). Groundwater discharge from shallow basalt
39 aquifers is probably to the overlying aquifers and to the Columbia River. The discharge
40 area(s) for the deeper groundwater system is uncertain, but flow is inferred to be
41 generally southeastward with discharge thought to be south of the Hanford Site (DOE
42 1988a).

Erosional "windows" through dense basalt flow interiors allow direct interconnection between the uppermost aquifer systems and underlying confined basalt aquifers. Graham et al. (1984) reported that some contamination was present in the uppermost confined aquifer (Rattlesnake Ridge interbed) south and east of Gable Mountain Pond. Graham et al. (1984) evaluated the hydrologic relationships between the Rattlesnake Ridge interbed aquifer and the unconfined aquifer in this area and delineated a potential area of intercommunication beneath the northeast portion of the 200 East Area.

The base of the uppermost aquifer system is defined as the top of the uppermost basalt flow. However, fine-grained overbank and lacustrine deposits in the Ringold Formation locally form confining layers for Ringold fluvial gravels underlying unit E. The uppermost aquifer system is bounded laterally by anticlinal basalt ridges and is approximately 152 m (500 ft) thick near the center of the Pasco Basin.

Sources of natural recharge to the uppermost aquifer system are rainfall and runoff from the higher bordering elevations, water infiltrating from small ephemeral streams, and river water along influent reaches of the Yakima and Columbia Rivers. The movement of precipitation through the unsaturated (vadose) zone has been studied at several locations on the Hanford Site (Gee 1987; Routson and Johnson 1990; Rockhold et al. 1990). Conclusions from these studies vary. Gee (1987) and Routson and Johnson (1990) conclude that no downward percolation of precipitation occurs on the 200 Areas Plateau where the sediments are layered and vary in texture, and that all moisture penetrating the soil is removed by evapotranspiration. Rockhold et al. (1990) suggest that downward water movement below the root zone is common in the 300 Area, where soils are coarse-textured and precipitation is above normal relative to the rest of the Hanford Site.

3.5.2 Hanford Site Hydrogeology

This section describes the hydrogeology of the Hanford Site with specific reference to the 200 Areas.

3.5.2.1 Hydrostratigraphy. The hydrostratigraphic units of concern in the 200 Areas are (1) the Rattlesnake Ridge interbed (confined water-bearing zone), (2) the Elephant Mountain Basalt Member (confining horizon), (3) the Ringold Formation (unconfined and confined water-bearing zones and lower part of the vadose zone), (4) the Plio-Pleistocene unit and early "Palouse" soil (primary vadose zone perching horizons and/or perched groundwater zones) and (5) the Hanford formation (vadose zone) (Figure 3-13). The Plio-Pleistocene unit and early "Palouse" soil are only encountered in the 200 West Area. Strata below the Rattlesnake Ridge interbed are not discussed because the more

significant water-bearing intervals, relating to environmental issues, are primarily closer to ground surface. The hydrogeologic designations for the 200 Areas were determined by examination of borehole logs and integration of these data with stratigraphic correlations from existing reports.

3.5.2.1.1 Vadose Zone. The vadose zone beneath the 200 Areas ranges from approximately 55 m (180 ft) beneath the former U Pond to approximately 104 m (318 ft) in the southern portion of the 200 East Area (Last et al. 1989). Sediments in the vadose zone consist of the (1) fluvial gravel of Ringold unit E, (2) the upper unit of the Ringold Formation, (3) Plio-Pleistocene unit, (4) early "Palouse" soil, and (5) Hanford formation. Only the Hanford formation is continuous throughout the vadose zone in the 200 Areas. The upper unit of the Ringold Formation, the Plio-Pleistocene unit, and the early "Palouse" soil only occur in the 200 West Area. In the 200 East Area the Plio-Pleistocene and early "Palouse" soil are absent. The unconfined aquifer water table (discussed in Section 3.5.2.1.3) lies within the Hanford formation or the Ringold units A or E where present.

The transport of water through the vadose zone depends in complex ways on several factors, including most significantly the moisture content of the soils and their hydraulic properties. Darcy's law, although originally conceived for saturated flow only, was extended by Richards to unsaturated flow, with the provisions that the soil hydraulic conductivity becomes a function of the water content of the soil and the driving force is predominantly differences in moisture level. The moisture flux, q , in cm/s in one direction is then described by a modified form of Darcy's law commonly referred to as Richards' Equation (Hillel 1971) as follows:

$$q = K(\theta) \times \frac{\partial \phi}{\partial \theta} \times \frac{\partial \theta}{\partial x} \text{ (Richards' Equation)}$$

where

- $K(\theta)$ is the water content-dependent unsaturated hydraulic conductivity in cm/s
- $\frac{\partial \phi}{\partial \theta}$ is the slope of the soil-moisture retention curve $\phi(\theta)$ at a particular volumetric moisture content θ (a soil-moisture retention curve plots volumetric moisture content observed in the field or laboratory against suction values for a particular soil, see Figure 3-33 from Gee and Heller [1985] for an example)
- $\frac{\partial \theta}{\partial x}$ is the water content gradient in the x direction.

More complicated forms of this equation are also available to account for the effects of more than one-dimensional flow and the effects of other driving forces such as gravity.

1 The usefulness of Richards' Equation is that knowing the moisture content
2 distribution in soil, having measured or estimated values for the unsaturated hydraulic
3 conductivity corresponding to these moisture contents, and having developed a moisture
4 retention curve for this soil, one can calculate a steady state moisture flux. With
5 appropriate algebraic manipulation or numerical methods, one could also calculate the
6 moisture flux under transient conditions.

7
8 In practice, applying Richards' Equation is quite difficult because the various
9 parameters involved are difficult to measure and because soil properties vary depending
10 on whether the soil is wetting or drying. As a result, soil heterogeneities affect
11 unsaturated flow even more than saturated flow. Several investigators at the Hanford
12 Site have measured the vadose zone moisture flux directly using lysimeters (e.g.,
13 Rockhold et al. 1990; Routson and Johnson 1990). These direct measurements are
14 discussed in Section 3.5.2.2 under the heading of natural groundwater recharge.

15
16 An alternative to direct measurement of unsaturated hydraulic conductivity is to use
17 theoretical methods that predict the conductivity from measured soil moisture retention
18 data.

19
20 Thirty-five soil samples from the 200 West Area have had moisture retention data
21 measured. These samples were collected from Wells 299-W18-21, 299-W15-16, 299-W15-
22 2, 299-W10-13, 299-W7-9, and 299-W7-2. Eleven of these samples were reported by
23 Bjornstad (1990). The remaining 24 were analyzed as part of an ongoing performance
24 assessment of the low-level burial grounds (Connelly et al. 1992). For each of these
25 samples saturated hydraulic conductivity was measured in the laboratory. Van
26 Genuchten's computer program RETC (Van Genuchten et al. 1991) was then used to
27 develop wetting and drying curves for the Hanford, early "Palouse," Plio-Pleistocene,
28 upper Ringold, and Ringold Gravel lithologic units. An example of the wetting and
29 drying curves, and corresponding grain size distributions, is provided on Figure 3-34.

30
31 The unsaturated hydraulic conductivities may vary by orders of magnitude with
32 varying moisture contents and among differing lithologies with significantly different soil
33 textures and hydraulic conductivities. Therefore, choosing a moisture retention curve
34 should be made according to the particle size analyses of the samples and the relative
35 density of the material.

36
37 Once the relationship between unsaturated hydraulic conductivity and moisture
38 content is known for a particular lithologic unit, travel time can also be estimated for a
39 steady-state flux passing through each layer by assuming a unit hydraulic gradient. Under
40 the unit gradient condition, only the force of gravity is acting on water and all other
41 forces are considered negligible. These assumptions may be met for flows due to natural
42 recharge since moisture differences become smoothed out after sufficient time. Travel

1 time for each lithologic unit of a set thickness and calculated for any given recharge rate
2 and the total travel time is equivalent to the sum of the travel times for each individual
3 lithologic unit. To calculate the travel time for any particular waste management unit the
4 detailed layering of the lithologic units should be considered. For waste management
5 units with artificial recharge (e.g., cribs and trenches) more complicated analyses would
6 be required to account for the effects of saturation.

7
8 Several other investigators have measured vadose zone soil hydraulic conductivities
9 and moisture retention characteristics at the Hanford Site both in situ (i.e., in lysimeters)
10 and in specially prepared laboratory test columns. Table 3-2 summarizes data identified
11 for this study by stratigraphic unit. Rockhold et al. (1988) presents a number of moisture
12 retention characteristic curves and plots of hydraulic conductivity versus moisture content
13 for various Hanford soils. For the Hanford formation, vadose zone hydraulic conductivity
14 values at saturation range from 10^{-4} to 10^{-2} cm/s. These saturated hydraulic conductivity
15 values were measured at volumetric water contents of 40 to 50 percent. Hydraulic
16 conductivity values corresponding to volumetric water contents, ranging from 2 to 10
17 percent, ranged from 2×10^{-11} to 7×10^{-7} cm/s.

18
19 An example of the potential use of this vadose zone hydraulic parameter
20 information is presented by Smoot et al. (1989) in which precipitation infiltration and
21 subsequent contaminant plume movement near a prototype single-shell tank was
22 evaluated using a numerical computer code. Smoot et al. (1989) used the UNSAT-H
23 one-dimensional finite-difference unsaturated zone water flow computer code to predict
24 the precipitation infiltration for several different soil horizon combinations and
25 characteristics. The researchers used statistically generated precipitation values that were
26 based on actual daily precipitation values recorded at the Hanford Site between 1947 and
27 1989 to simulate precipitation infiltration from January 1947 to December 2020. The
28 same authors also used the PORFLO-3 computer code to simulate ^{106}Ru and ^{137}Cs
29 movement through the unsaturated zone.

30
31 Smoot et al. (1989) concluded that 68 to 86 percent of the annual precipitation
32 infiltrated into a gravel-capped soil column while less than 1 percent of the annual
33 precipitation infiltrated into a silt loam-capped soil column. For the gravel-capped soil
34 column, the simulations showed the ^{106}Ru plume approaching the water table after 10
35 years of simulated precipitation infiltration. The simulated ^{137}Cs plume migrated a
36 substantially shorter distance due to greater adsorption on soil particles. In both cases,
37 the simulated plume migration scenarios are considered to be conservative due to the
38 relatively low soil absorption coefficients used.

39
40 Graham et al. (1981) estimated that historical artificial recharge from liquid waste
41 disposal in the 200 (Separations) Areas exceeded all natural recharge by a factor of ten.
42 In the absence of ongoing artificial recharge, i.e., liquid waste disposal to the soil column,

1 natural recharge could potentially be a driving force for mobilizing contaminants in the
2 subsurface. Natural sources of recharge to the vadose zone and the underlying water
3 table aquifer are discussed in Section 3.5.2.2. Additional discussion of the potential for
4 natural and artificial recharge to mobilize subsurface contaminants is presented in
5 Section 4.2.

6
7 Another facet of moisture migration in the vadose zone is moisture retention above
8 the water table. Largely because of capillary forces, some portion of the moisture
9 percolating down from the ground surface to the unconfined aquifer will be held against
10 gravity in soil pore space. Finer-grained soils retain more water (against the force of
11 gravity) on a volumetric basis than coarse-grained soils (Hillel 1971). Because
12 unsaturated hydraulic conductivity increases with increasing moisture content,
13 finer-grained soils may be more permeable than coarse-grained soils at the same water
14 content. Also, because the moisture retention curve for coarse-grained soils is generally
15 quite steep (Smoot et al. 1989), the permeability contrast between fine-grained and
16 coarse-grained soils at the same water content can be substantial. The occurrence of
17 interbedded fine-grained and coarse-grained soils may result in the formation of "capillary
18 barriers" and can in turn lead to the formation of perched water zones. General
19 conditions leading to the formation of perched water zones at the Hanford Site and the
20 potential for perched water zones in the Semi-Works Aggregate Area are discussed in
21 Section 3.5.3.1.2.

22
23 **3.5.2.1.2 Perched Water Zones.** Moisture moving downward through the vadose
24 zone may accumulate on top of highly cemented horizons and may accumulate above the
25 contact between a fine-grained horizon and an underlying coarse-grained horizon as a
26 result of the "capillary barrier" effect. If sufficient moisture accumulates, the soil pore
27 space in these perching zones may become saturated. In this case, the capillary pressure
28 within the horizon may locally exceed atmospheric pressure, i.e., a water table condition
29 may develop. Additional input of downward percolating moisture to this horizon may
30 lead to a hydraulic head buildup above the top of the horizon. Consequently, a
31 monitoring well screened within or above this horizon would be observed to contain free
32 water.

33
34 Within the 200 East Area, the Hanford formation contains locally discontinuous
35 lenticular silty paleosols throughout the sand and gravel bodies (Lindsey et al. 1992) that
36 may potentially promote perched water zones near active discharge sites.

37
38 As discussed earlier, the Plio-Pleistocene unit and the early "Palouse" soil do not
39 occur in the 200 East Area. In the vicinity of the 200 West Area, however, the lateral
40 extent and composition of the Plio-Pleistocene and early "Palouse" soil units may provide
41 conditions amenable to the formation of perched water zones in the vadose zone above
42 the unconfined aquifer. The calcrete facies of the Plio-Pleistocene unit, consisting of

1 calcium-carbonate-cemented silt, sand, and gravel, is a potential perching horizon due to
2 its likely low hydraulic conductivity. However, the Plio-Pleistocene unit is typically
3 fractured and may have erosional scours in some areas, potentially allowing deeper
4 infiltration of groundwater, a factor which may limit the lateral extent of accumulated
5 perched groundwater. The early "Palouse" soil horizon, consisting of compact, loess-like
6 silt and minor fine-grained sand, is also a likely candidate for accumulating moisture
7 percolating downward through the sand and gravel-dominated Hanford formation.
8

9 **3.5.2.1.3 Unconfined Aquifer.** The uppermost aquifer system in the 200 Areas
10 occurs primarily within the sediments of the Ringold Formation and Hanford formation.
11 In the 200 West Area the upper aquifer is contained within the Ringold Formation and
12 displays unconfined to locally confined or semiconfined conditions. In the 200 East Area
13 the upper aquifer occurs in the Ringold Formation and Hanford formation. The depth
14 to groundwater in the upper aquifer underlying the 200 Areas ranges from approximately
15 60 m (197 ft) beneath the former U Pond in the 200 West Area to approximately 105 m
16 (340 ft) west of the 200 East Area to approximately 103 m (313 ft) near the 202-A
17 Building in the 200 East Area. The saturated thickness of the unconfined aquifer ranges
18 from approximately 67 to 112 m (220 to 368 ft) in the 200 West Area and approximately
19 61 m (200 ft) in the southern 200 East Area to nearly absent in the northeastern 200
20 East Area where the aquifer thins out and terminates against the basalt located above
21 the water table in that area.
22

23 The upper part of the uppermost aquifer in the 200 East Area consists of generally
24 unconfined groundwater within the Ringold unit E. In the northern part of the Semi-
25 Works Aggregate Area the Ringold Formation has been eroded and the groundwater is
26 found within the Hanford formation. The lower part of the uppermost aquifer consists
27 of confined to semi-confined groundwater within the gravelly sediments of Ringold unit
28 A. The Ringold unit A is generally confined by fine-grained sediments of the lower mud
29 sequence.
30

31 Because of its importance with respect to contaminant transport, the unconfined
32 aquifer is generally the most characterized hydrologic unit beneath the Hanford Site. A
33 number of observation wells have been installed and monitored in the unconfined
34 aquifer. Additionally, in situ aquifer tests have been conducted in a number of the
35 unconfined aquifer monitoring wells. Results of these in situ tests vary greatly depending
36 on the following:
37

- 38 • Horizontal position/location between areas across the Hanford Site and even
39 smaller areas (such as across portions of the 200 Areas)
40
- 41 • Depth, even within a single hydrostratigraphic unit
42

- Analytical methods for estimating hydraulic conductivity.

Details regarding this aquifer system can be found in the 200 East Groundwater Aggregate Area Management Study Report.

3.5.2.2 Natural Groundwater Recharge. Sources of natural recharge to groundwater at the Hanford Site include precipitation infiltration, runoff from higher bordering elevations and subsequent infiltration within the Hanford Site boundaries, water infiltrating from small ephemeral streams, and river water infiltrating along influent reaches of the Yakima and Columbia Rivers (Graham et al. 1981). The principal source of natural recharge is believed to be precipitation and runoff infiltration along the periphery of the Pasco Basin. Small streams such as Cold Creek and Dry Creek also lose water to the ground as they spread out on the valley plain. Considerable debate exists as to whether any recharge to groundwater occurs from precipitation falling on broad areas of the 200 Areas Plateau.

Natural precipitation infiltration at or near waste management units or unplanned releases may provide a driving force for the mobilization of contaminants previously introduced to surface or subsurface soils. For this reason, determination of precipitation recharge rates at the Hanford Site has been the focus of many previous investigations. Previous field programs have been designed to assess precipitation, infiltration, water storage changes, and evaporation to evaluate the natural water balance during the recharge process. Precipitation recharge values ranging from 0 to 10 cm/yr have been estimated from various studies.

The primary factors affecting precipitation recharge appear to be surface soil type, vegetation type, topography, and year-to-year variations in seasonal precipitation. A modeling analysis (Smoot et al. 1989) indicated that 68 to 86 percent of the precipitation falling on a gravel-covered site might infiltrate to a depth greater than 2 m (6 ft). As discussed below, various field studies suggest that less than 25 percent of the precipitation falling on typical Hanford Site soils actually infiltrates to any depth.

Examples of precipitation recharge studies include:

- A study by Gee and Heller (1985) described various models used to estimate natural recharge rates. Many of the models use a water retention relationship for the soil. This relates the suction required to remove (or move) water to its dryness (saturation or volumetric moisture content). Two of these have been developed by Gee and Heller (1985) for soils in lysimeters on the Hanford Site. As an example of available data, the particle size distribution and the water retention curves of these two soils are shown on Figure 3-34.

Additional data and information about possible models for unsaturated flow may be found in Brownell et al. (1975), and Rockhold et al. (1990).

- Moisture contents have been obtained from a number of core-barrel samples in the 200 Areas (East and West) and varied from 1 to 18 percent, with most in the range of 2 to 6 percent (Last et al. 1989). The data appear to indicate zones of increased moisture content that could be interpreted as signs of moisture transport.
 - A lysimeter study reported by Routson and Johnson (1990) was conducted at a location 1.6 km south of the 200 East Area. During much of the lysimeters' 13-year study period between 1972 and 1985, the surface of the lysimeters were maintained unvegetated with herbicides. No information regarding the soil types in the lysimeters was found. To a precision of +/- 0.2 cm, no downward moisture movement was observed in the instruments during periodic neutron-moisture measurements or as a conclusion of a final soil sample collection and moisture content analysis episode.
 - An assessment of precipitation recharge involving the redistribution of ^{137}Cs in vadose zone soil was also reported by Routson and Johnson (1990). In this study, split-spoon soil samples were collected beneath a solid waste burial trench in the T Plant Aggregate Area. The trench, located just south and west of the 218-W-3AE Burial Ground, approximately 6 km (3.7 mi) west of the 200 East Area, received soil containing ^{137}Cs from an unspecified spill. Cesium-137 was not detected below the bottom of the burial trench. However, increased ^{137}Cs activity was observed above the top of the waste fill which Routson and Johnson concluded indicated that net negative recharge (loss of soil moisture to evapotranspiration) had occurred during the 10-year burial period.
- Sparse Russian thistle was observed at the burial trench area in 1980. Rockhold et al. (1990) noted that ^{137}Cs appears to strongly sorb to Hanford Site soils indicating that the absence of the radionuclide at depth below the burial trench may not support the conclusion that no downward moisture movement occurred.
- A weighing lysimeter study reported by Rockhold et al. (1990) was conducted at a grassy plot approximately 5 km (3 mi) northwest of the 300 Area. The grass test site was located in a broad, shallow topographic depression approximately 900 m (2,953 ft) wide, several hundred meters long, trending southwest. The area is covered with annual grasses (cheatgrass and bluegrass). The upper 3.5 m (11.5 ft) of the soil profile consists of slightly

1 silty to silty sand (sandy loam) with an estimated saturated hydraulic
2 conductivity of 9×10^{-3} cm/s. Rockhold et al. (1990) estimated that
3 approximately 0.8 cm (0.3 in.) of downward moisture movement occurred
4 between July 1987 and June 1988. This represents approximately 7 percent of
5 the total precipitation recorded in that area during that time period.

- 6
- 7 • A gravel-covered lysimeter study discussed by Rockhold et al. (1990) was
8 conducted at the 200 East Area lysimeter site, approximately 1 km (1.6 mi)
9 south of the 200 East Area. Water contents below the 4.88 m (16 ft) depth in
10 the closed-bottom lysimeter have not changed reasonably between 1972 and
11 1988, implying that significant recharge has not occurred. Data are
12 insufficient to conclude whether the presence of a plant community on the
13 lysimeter is the reason for the lack of water increase.
- 14

15 The drainage (downward moisture movement) observed in these studies may
16 represent potential recharge to deeper vadose zone soils and/or the underlying water
17 table.

18

19 **3.5.2.3 Groundwater Flow.** Groundwater flow north of Gable Mountain currently trends
20 in a northeasterly direction as a result of mounding near reactors and flow through Gable
21 Gap. South of Gable Mountain, flow is interrupted locally by the groundwater mounds
22 in the 200 Areas (Figure 3-35). There is also a component of groundwater flow to the
23 north between Gable Mountain and Gable Butte from the 200 Areas. In the 200 East
24 Area, groundwater elevations in June 1990 for the unconfined aquifer showed little
25 variation and were generally around 133 m (405 ft) (Kasza et al. 1990).

26

27 Temporary reversal of groundwater flow entering the Columbia River may occur
28 during transient, high-river stages. This occurrence is known as bank storage.
29 Correlations were made between groundwater level and river-stage fluctuations along a
30 81 km (50 mi) reach of the Columbia River adjacent to the Hanford Site by Newcomb
31 and Brown (1961). They concluded that a 260 km² (100 mi²) area within the Hanford
32 Site was affected by bank storage. During a 45-day rise in river stage, it was estimated
33 that water infiltrated at an average rate of 4,500,000 m³/day (3,700 acre-ft/day) versus
34 1,233,000 m³/day (1,000 acre-ft/day) during the 165-day recession period. Since this study
35 was conducted, dam control on the Columbia River has reduced the magnitude of bank
36 storage on the groundwater system.

37

38 Natural groundwater inflow to the unconfined aquifer primarily occurs along the
39 western boundary of the Hanford Site. Currently, man-made recharge occurs in several
40 active waste management units (e.g., the 216-U-14 Ditch, 216-U-17 Crib, and the 216-Z-
41 20 Crib) located within the U Plant Aggregate Area in the 200 West Area. Historically,
42 much greater recharge occurred from a number of waste management units in the 200

1 Areas. Man-made recharge probably substantially exceeds natural precipitation recharge
2 in these areas. The unconfined aquifer ultimately discharges to the Columbia River,
3 either near the 100 Areas, north of the 200 Areas through Gable Gap, or between the
4 100 Areas and the 300 Area, east of the 200 Areas. The precise path is strongly
5 dependent on the hydrologic conditions in the 200 East Area (Delaney et al. 1991).
6 Generally, groundwater flow is from the west towards the east-southeast. Artificial
7 recharge from the 216-B-3 Pond System in the neighboring B Plant Aggregate Area has
8 produced a groundwater mound which has altered the hydraulic gradients and
9 groundwater flow direction throughout the 200 East Area. The result of this flow
10 convergence in the development of a large groundwater "saddle" beneath the 200 East
11 Area. The overall effect of the "saddle" is that groundwater flow is partitioned in two
12 primary directions: north through the Gable Gap area and southeast towards Richland.
13 Locally, within the 200 East Area groundwater, flow direction is difficult to determine
14 and can be variable due to extremely low hydraulic gradient and effects of variable
15 discharges to the 216-B-3 Pond System.

16
17 **3.5.2.4 Historical Effects of Operations.** Historical effluent disposal at the Hanford Site
18 altered previously prevailing groundwater hydraulic gradients and flow directions. Before
19 operations at the Hanford Site began in 1944, groundwater flow was generally toward the
20 east, and the groundwater hydraulic gradient in the 200 East Area was on the order of
21 0.0003 (Delaney et al. 1991). Prior to disposing liquid waste to the soil column in the 200
22 (Separations) Areas, groundwater elevations in the 200 East Area may have been as
23 much as 18 m (55 ft) lower in 1944 than at present. As seen on Figure 3-35, a distinct
24 groundwater mound is still apparent east of the 200 East Area near the 216-B-3 Pond.
25 The 216-B-3 Pond has caused the groundwater flow direction to change to a northwest-
26 southeast flow pattern.

27 28 29 **3.5.3 Semi-Works Aggregate Area Hydrogeology**

30
31 This section presents additional hydrogeologic information identified with specific
32 application to the Semi-Works Aggregate Area.

33
34 **3.5.3.1 Hydrostratigraphy.** As shown on Figure 3-36, the pertinent hydrostratigraphic
35 units beneath the Semi-Works Aggregate Area are (1) the Rattlesnake Ridge interbed,
36 (2) the Elephant Mountain Basalt Member, (3) the Ringold Formation unit A and
37 (4) the Hanford formation. The hydrogeologic designations for the Semi-Works
38 Aggregate Area were determined by examination of borehole logs from Lindsey et al.
39 (1992) and integration of these data with stratigraphic correlations from existing reports
40 and well logs. For the purposes of the Semi-Works AAMS, this discussion will be limited
41 to the vadose zone and possible perching horizons with the vadose zone underlying the

aggregate area. Additional information on the aquifer systems can be found in the 200 East Groundwater AAMS.

3.5.3.1.1 Vadose Zone. The vadose zone beneath the Semi-Works Aggregate Area is approximately 87 m (285 ft) thick with minor variation due to changes in surface topography and water table elevation.

Published vadose zone hydraulic data specific to the Semi-Works Aggregate Area were not found. However, studies were done for the Grout Facility (DOE 1990) located approximately 1.5 km to the southeast of the Semi-Works Aggregate Area with similar geology. Analysis of borehole samples there indicate that the moisture content of sediments ranges from 2 to 7 percent with localized zones ranging as high as 20 percent associated with finer grained layers. The CaCO_3 content is typically less than 5 percent with locally higher areas. RCRA groundwater monitoring wells installed in the 241-C and A-AX Tank Farms in 1989 typically have moisture contents between 1.5 and 7 percent with peak values ranging as high as 25 percent. Conditions in the Semi-Works Aggregate Area are probably similar.

Field and laboratory studies were conducted of the upper 3.5 to 20 m (11 to 65 ft) of the grout facility to determine hydraulic conductivity and also can be applied to the Semi-Works Aggregate Area. Values for falling-head permeability test range from 1.5×10^{-3} to 2.9×10^{-2} cm/s. Laboratory constant-head permeability values range from 1.2×10^{-4} to 2.0×10^{-3} cm/s. Studies also show a horizontal-to-vertical conductivity anisotropy of 13:1. Studies done in the U Plant area of 200 West (Goodwin and Bjornstad 1990) may also be applicable.

3.5.3.1.2 Perched Water Zones. As discussed in Section 3.5.2.1.2, the primary potential for perched water is associated with the silt lense paleosols throughout the Hanford formation sands and gravels. Unlike the 200 West Area, the Plio-Pleistocene unit and early "Palouse" soil are not present and therefore do not form potential perching layers. Perching potential is greatest near the 200 East Powerhouse Ditch along the southern border of the Semi-Works Aggregate Area because of the large quantity of water being discharged. Perched water is also possible near the former 216-C-9 Pond Site where considerable quantities of liquid waste were discharged to the soil column.

3.5.3.2 Natural and Artificial Groundwater Recharge. As discussed in Section 3.3.3, no natural surface water bodies exist within the Semi-Works Aggregate Area. Potential recharge is limited to precipitation infiltration or artificial recharge from the 200 East Powerhouse Ditch in the south side of the area. Wastewater discharges to the 200 East Powerhouse Ditch are discussed in Section 3.2.3. No infiltration data are identified with specific reference to the Semi-Works Aggregate Area but precipitation infiltration is

likely to be similar to values obtained in other parts of the Hanford Site and range from 0 to 10 cm/yr.

As suggested in Section 3.5.2.2, precipitation infiltration rates probably vary with respect to location within the Semi-Works Aggregate Area. Higher infiltration rates are expected in unvegetated areas or areas with shallow rooting plants.

3.5.3.3 Groundwater Flow Beneath the Semi-Works Aggregate Area. As indicated on Figure 3-35, the Semi-Works Aggregate Area is located between groundwater mounds emanating from the 200 West Area to the west and the B Plant Pond to the east. Consequently, there is very little gradient to the groundwater table beneath the site. Based on the 1991 RCRA Groundwater Monitoring Annual Report, groundwater flow is probably in a westerly or southwesterly direction beneath the Semi-Works Aggregate Area.

3.5.3.4 Historical Effects of Operations. Artificial recharge from waste management facilities within the 200 East Area has caused significant changes to the water levels of the unconfined aquifer since operations began in 1943. Historically, the majority (greater than 90 percent) of wastewater discharged from the 200 East Area has been routed to the B or Gable Mountain Ponds (Zimmerman et al. 1986). Between 1943 and 1980 approximately 3.433×10^{11} L of wastewater had been discharged to these ponds. The B Pond received greater than 90 percent of the wastewater generated from the 200 East Area between 1945 and 1955. In 1957 the Gable Mountain Pond began receiving wastewater. From 1956 to 1980 these ponds received over 90 percent of the wastewater generated from the 200 East Area. This discharging has created elevated groundwater levels, or mounding of the groundwater, in the vicinity of the B and Gable Mountain Ponds.

Between 1950 and 1955 small groundwater elevation increases occurred south of Gable Mountain in response to wastewater discharges from the B Plant. Groundwater mounding in the vicinity of the B Pond continued in response to the startup of the PUREX Plant in 1956 and new discharges to the Gable Mountain Pond. During this time the artificial recharge caused elevations to reach approximately 10 m (32 ft) above the natural groundwater elevations.

During the 1960s the groundwater mound grew at a much slower rate and reached near equilibrium conditions during the 1970s. During the 1980s, three expansion ponds were created near the B Pond to receive wastewater redirected from the Gable Mountain Pond and the PUREX Plant which resumed production in 1983. This increased discharge amount has elevated groundwater levels in the vicinity of the B Pond approximately 1.5 m (5 ft) between December 1979 and December 1989. Groundwater

elevations in the vicinity of the Gable Mountain Pond have decreased approximately 1 m (3 ft) during this same time.

3.6 ENVIRONMENTAL RESOURCES

The Hanford Site is characterized as a cool desert or a shrub-steppe and supports a biological community typical of this environment.

3.6.1 Flora and Fauna

The 200 Areas Plateau is represented by a number of plant, mammal, bird, reptile, amphibian, and insect species as discussed below.

3.6.1.1 Vegetation of the 200 Areas Plateau. The vegetation of the 200 Areas Plateau is characterized by native shrub steppe interspersed with large areas of disturbed ground with a dominant annual grass component. The native stands are classified as an *Artemisia tridentata*/*Poa sandbergii* - *Bromus tectorum* community (Rogers and Rickard 1977) meaning that the dominant shrub is Big Sagebrush (*Artemisia tridentata*) and the understory is dominated by the native Sandberg's Bluegrass (*Poa sandbergii*) and the introduced annual Cheatgrass (*Bromus tectorum*). Other shrubs that are typically present include Gray Rabbitbrush (*Chrysothamnus nauseosus*), Green Rabbitbrush (*C. viscidiflorus*), Spiny Hopsage (*Grayia spinosa*), and occasionally Antelope Bitterbrush (*Pursia tridentata*). Other native bunchgrasses that are typically present include Bottlebrush Squirreltail (*Sitanion hystrix*), Indian Ricegrass (*Oryzopsis hymenoides*), Needle-and-Thread (*Stipa comata*), and Prairie Junegrass (*Koeleria cristata*). Common and important herbaceous species include Turpentine cymopteris (*Cymopterus terebinthinus*), Globemallow (*Sphaeralcea munroana*), balsamroot (*Basamorhiza careyana*), several Milkvetch species (*Astragalus caricinus*, *A. sclerocarpus*, *A. succumbens*), Long-leaf Phlox (*Phlox longifolia*), the common Yarrow (*Achillea millefolium*), Pale Evening-primrose (*Oenothera pallida*), Thread-leaf phacelia (*Phacelia linearis*), and several Daisy/Fleabane Species (*Erigeron poliospermus*, *E. filifolius*, and *E. pumilus*). In all, well over 100 plant species have been documented to occur in native stands on the 200 Areas Plateau.

Disturbed communities on the 200 Areas Plateau are primarily the result of either mechanical disturbance or range fires. Mechanical disturbance, including construction activities, soil borrow areas, road clearings, and fire breaks, results in drastic changes to the plant community. This type of disturbance usually entails a complete loss of soil structure and total disruption of nutrient cycling. The principle colonizers of mechanically disturbed areas are the annual weeds Russian Thistle (*Salsola kali*), Jim Hill

1 Mustard (*Sisymbrium altissimum*), and Bur-ragweed (*Ambrosia acanthicarpa*). If no
2 further disturbance occurs, the areas will eventually become dominated by cheatgrass.
3 All of these annual weeds are occasionally found in native stands, but only at relatively
4 low frequencies.

5 Range fires also have dramatic effects on the overall ecosystem, the most obvious
6 being the complete removal of Sagebrush from the community, and the rapid increase in
7 cheatgrass coverage. Unlike the native grasses, the other important shrubs, and many of
8 the perennial herbaceous species, Sagebrush is unable to resprout from rootstocks after
9 being burned. Therefore, there is no dominant shrub component in burned areas until
10 Sagebrush is able to become re-established from seed. Burning also opens the
11 community to the invasion by cheatgrass, which is capable of quickly utilizing the
12 nutrients that are released through burning. The extensive cover of cheatgrass may then
13 prevent the re-establishment of many of the native species, including Sagebrush. The
14 species richness in formerly burned areas is usually much lower than in native stands,
15 often consisting of only Cheatgrass, Sandberg's Bluegrass, Russian thistle, and Jim Hill
16 Mustard, with very few other species.

17
18 The vegetation in and around the ponds and ditches on the 200 Areas Plateau is
19 significantly different from that of the surrounding dryland areas. Several tree species
20 are present, especially Cottonwood (*Populus trichocarpa*) and Willows (*Salix* spp.). A
21 number of wetland species are also present including several sedges (*Carex* spp.),
22 bulrushes (*Scirpus* spp.), Cattails (*Typha latifolia* and *T. angustifolia*), and pond-weeds
23 (*Potamogeton* spp.).

24
25 **3.6.1.2 Plant Species of Concern.** The Washington State Department of Natural
26 Resources, Natural Heritage Program classifies rare plants in the State of Washington in
27 three different categories, depending on the overall distribution of the taxon and the
28 state of its natural habitat. These categories are: *Endangered*, which is a "vascular plant
29 taxon in danger of becoming extinct or extirpated in Washington within the near future if
30 factors contributing to its decline continue. Populations of these taxa are at critically low
31 levels or their habitats have been degraded or depleted to a significant degree";
32 *Threatened*, which is a "vascular plant taxon likely to become endangered within the near
33 future in Washington if factors contributing to its population decline or habitat
34 degradation or loss continue"; and *Sensitive*, which is a taxon that is "vulnerable or
35 declining, and could become endangered or threatened in the state without active
36 management or removal of threats" (definitions taken from the Natural Heritage
37 Program [1990]). Of concern to the Hanford Site, there are two Endangered taxa, two
38 Threatened taxa, and at least eleven Sensitive taxa; these are listed in Table 3-3. All
39 four of the Threatened and Endangered taxa are presently candidates for the Federal
40 Endangered Species List.

Of the two Endangered taxa, Persistent-sepal Yellowcress is well documented along the banks of the Columbia River throughout the 100 Areas, it is unlikely to occur in the 200 Areas. The Northern Wormwood is known in the State of Washington by only two populations, one across from The Dalles, Oregon, and the other near Beverly, Washington, just north of the Hanford Site. This taxon has not been found on the Hanford Site, but would probably occur only on rocky areas immediately adjacent to the Columbia River if it were present. Neither of the Threatened taxa listed in Table 3-2 has been observed on the Hanford Site. The Columbia Milk-vetch is known to be relatively common on the Yakima Firing Range, and has been documented to occur within 1.6 to 3.2 km (1 to 2 mi) to the west of the Hanford Site on both sides of Umptanum Ridge. This species could occur on the 200 Areas Plateau. Hoover's Desert Parsley inhabits the steep talus slopes near Priest Rapids Dam. Potentially, it could be found on similar slopes on Gable Mountain and Gable Butte, but has yet to be documented in these areas.

Of the Sensitive species, five are inhabitants of aquatic or moist habitats and the other six are inhabitants of dry upland habitats. Dense Sedge, Shining Flatsedge, Southern Mudwort, and False Pimpernel are all known to occur in the 100 Areas, especially near the B-C Area, in or near the Columbia River. Some of these species could be present in or near ponds and ditches in the 200 Areas. The few-flowered collinsia may also occur in these habitats. The Gray Cryptantha occurs on open dunes throughout the Hanford Site. Piper's Daisy is fairly common on Umptanum Ridge and Rattlesnake Ridge, but has also been documented in the vicinity of B Pond, the 216-A-24 Crib, and 100-H Area. Bristly Cryptantha, Dwarf Evening-primrose have been found at the south end of the White Bluffs, approximately 3.2 km (2 mi) upstream from the 300 Area. The Palouse Milk-vetch and Coyote tobacco are not as well documented but are known to inhabit dry sandy areas such as the 200 Areas Plateau.

In addition to the three classifications for species of concern listed above, the Natural Heritage Program also maintains a "Monitor" list, which is divided into three groups. Group 1 consists of taxa in need of further field work before a formal status can be assigned. The Tooth-sepal Dodder (*Cuscuta denticulata*), which has been found in the State of Washington only on the Hanford Site is the only taxon in this group that is of concern to Hanford operations. This parasitic species has been found in the area west of McGee Ranch. Group 2 of the Monitor list includes species with unresolved taxonomic questions. Thompson's sandwort (*Arenaria franklinii* var. *thompsonii*) is of concern to Hanford operations. However, the representatives of this species in the State of Washington are now believed to all be variety *franklinii* which is not considered particularly rare. Group 3 of the Monitor list includes taxa that are either more abundant or less threatened than previously believed. There are approximately 15 taxa on the Hanford Site that are included on this list

1 **3.6.1.3 Fauna of the 200 Areas Plateau.** The mammals, birds, reptiles and amphibians,
2 and insects inhabiting the 200 Areas Plateau are discussed below.

3
4 **3.6.1.3.1 Mammals.** The largest mammal occurring on the 200 Area Plateau is the
5 mule deer (*Odocoileus hemionus*). Although mule deer are much more common to
6 riparian sites along the Columbia River they are frequently observed foraging throughout
7 the 200 Areas. Elk (*Cervus elaphus*) also occur at Hanford but they have only been
8 observed at the Arid Lands Ecology Reserve. Other mammal species common to the
9 200 Areas include badgers (*Taxidea taxus*), coyotes (*Canis latrans*), blacktail jackrabbits
10 (*Lepus californicus*), Townsend ground squirrels (*Spermophilus townsendii*), Great Basin
11 pocket mice (*Perognathus parvus*), pocket gophers (*Thomomys talpoides*), and deer mice
12 (*Peromyscus maniculatus*). Badgers are known for their digging capability and have been
13 implicated several times for encroaching into inactive burial grounds throughout the 200
14 Areas. The majority of the badger excavations in the 200 Areas are a result of badgers
15 searching for prey (mice and ground squirrels). Coyotes are the principal predators,
16 consuming such prey as rodents, insects, rabbits, birds, snakes and lizards. The Great
17 Basin pocket mouse is the most abundant small mammal, which thrives in sandy soils and
18 lives entirely on seeds from native and revegetated plant species. Townsend ground
19 squirrels are not abundant in the 200 Areas but they have been seen at several different
20 sites. Other small mammals that occur in low numbers include the Western harvest
21 mouse (*Reithrodontomys megalotis*) and the Grasshopper mouse (*Onychomys leucogaster*).
22 Mammals associated more closely with buildings and facilities include Nuttall's cottontails
23 (*Sylvilagus nuttallii*), house mice (*Mus musculus*), Norway rats (*Rattus norvegicus*), and
24 some bat species. Bats probably play a minor role in the 200 Areas' ecosystem but no
25 documentation is available on bat populations at Hanford. Mammals such as skunks
26 (*Mephitis mephitis*), raccoons (*Procyon lotor*), weasels (*Mustela* spp.), porcupines
27 (*Erethizon dorsatum*), and bobcats (*Lynx rufus*) have only been observed on very few
28 occasions.

29
30 **3.6.1.3.2 Birds.** Over 235 species of birds have been documented to occur at the
31 Hanford Site (Landeem et al. 1991). At least 100 of these species have been observed in
32 the 200 Areas. The most common passerine birds include starlings (*Sturnus vulgaris*),
33 horned larks (*Ermophila alpestris*), meadowlarks (*Sturnella neglecta*), Western kingbirds
34 (*Tyrannus verticalis*), rock doves (*Columba livia*), barn swallows (*Hirundo rustica*), cliff
35 swallows (*Hirundo pyrrhonota*), black-billed magpies (*Pica pica*) and ravens (*Corvus*
36 *corax*). Common raptors include the Northern harrier (*Circus cyaneus*), American kestrel
37 (*Falco sparverius*), and Red tailed hawk (*Buteo jamaicensis*). Swainson's hawks (*Buteo*
38 *swainsoni*) sometimes nest in the trees located at some of the army bunker sites that
39 were used in the 1940's. Golden eagles (*Aquila chrysaetos*) are observed infrequently.
40 Burrowing owls (*Athene cunicularia*) nest at several locations throughout the 200 Areas.
41 The most common upland game birds found in the 200 Areas are California Quail
42 (*Callipepla californica*) and Chukar partridge (*Alectoris chukar*), however, Ring-necked

1 pheasants (*Phasianus colchicus*) and Gray partridge (*Pertx perdix*) may be found in limited
2 numbers. The only native game bird common to the 200 Areas Plateau is the Mourning
3 dove (*Zenaida macrora*) which migrates south each fall. Other species of note which nest
4 in undisturbed sagebrush habitats in the 200 Areas include Sage sparrows (*Amphispiza*
5 *belli*), and Loggerhead shrikes (*Lanius ludovicianus*). Long-billed Curlews (*Numenius*
6 *americanus*) also use the sagebrush areas and revegetated burial grounds for nesting and
7 foraging.

8
9 Waterfowl and aquatic birds inhabit 216-B-3 Pond and other areas where there is
10 running or standing water. However many of these areas such as 216-A-29 Ditch are
11 becoming more scarce due to stabilization and remedial action cleanup activities.
12 Aquatic birds and waterfowl common to 216-B-3 Pond on a seasonal basis include
13 Canada Geese (*Branta canadensis*), American coot (*Fulica americana*), Mallard (*Anas*
14 *platyrhynchos*), Ruddy duck (*Oxyura jamaicensis*), Redhead (*Aythya americana*),
15 Bufflehead (*Bucephala albeola*) and Great blue heron (*Ardea herodias*).

16
17 **3.6.1.3.3 Reptiles and Amphibians.** Common reptiles include gopher snakes
18 (*Pituophis melanoleucus*) and sideblotched lizards (*Uta stansburiana*). Other reptiles and
19 amphibians that are infrequently observed include sagebrush lizards (*Sceloporus*
20 *graciosus*), horned toads (*Phrynosoma douglassi*), western spadefoot toads (*Scaphiopus*
21 *intermontana*), yellow-bellied racer (*Coluber constrictor*), Pacific rattlesnake (*Crotalus*
22 *viridis*), and striped whipsnake (*Masticophis taeniatus*). Both lizards and snakes are prey
23 items of mammalian and avian predators.

24
25 **3.6.1.3.4 Insects.** There are hundreds of insect species which inhabit the 200
26 Areas. Two of the most common groups of insects include several species of darkling
27 beetles and grasshoppers. Harvester ants are also common and have been implicated in
28 the uptake of radionuclides from some of the burial grounds in the 200 East Area.
29 Harvester ants have the ability to excavate and bring up material from as far down as 4.6
30 to 6.1 m (15 to 20 ft). Other major groups of insects include bees, butterflies and scarab
31 beetles. Insects impact the surrounding plant community as well as serving as the prey
32 base for many species of birds, reptiles and mammals.

33
34 **3.6.1.4 Wildlife Species of Concern.** Some animals that inhabit the Hanford Site have
35 been given special status designations by the state and federal government. Some of
36 these designations include state and federal threatened and endangered species, federal
37 candidate, state monitor, state sensitive, and state candidate species. Species listed in
38 Table 3-3 as state and/or federal threatened and endangered such as the bald eagle
39 (*Haliaeetus leucocephalus*), peregrine falcon (*Falco peregrinus*), American white pelican
40 (*Pelecanus erythrorhynchos*), ferruginous hawk (*Buteo regalis*), and sandhill crane (*Grus*
41 *canadensis*) do not inhabit the 200 Areas. The bald eagle and American white pelican
42 utilize the Columbia River and associated habitats for roosting and feeding. Peregrine

1 falcons and sandhill cranes fly over the Hanford Site during migration. Ferruginous
2 hawks nest on the Hanford Site but nesting has not been documented for this species on
3 the 200 Areas Plateau. Other species listed in Table 3-4 as state and/or federal
4 candidates and state monitor species such as burrowing owls, Great Blue Herons, Prairie
5 falcons (*Falco mexicanus*), Sage sparrows, and Loggerhead shrikes are not uncommon to
6 the 200 Areas Plateau.

9 3.6.2 Land Use

10
11 The Semi-Works Aggregate Area is the location of the 201-C Process Building, the
12 Critical Mass Laboratory, and their attendant facilities and structures. In the past, the
13 201-C Process Building and related facilities served as a pilot plant for both the REDOX
14 and PUREX processes, and later was used for the recovery of strontium from fission
15 product waste. Three of these buildings (215-C, 2704-C and 276-C) are still in use
16 (Deford 1992). The 201-C Process Building was decommissioned in 1987. There are no
17 active waste management units associated with this building.

18
19 The Critical Mass Laboratory (209-E Building) was used for criticality experiments
20 through 1983. Since then, its associated administrative offices have been used
21 intermittently. Three waste units (216-C-7 Crib, 2607-E-5 Septic Tank, 2607-E-7A Septic
22 Tank) are still active. In addition, the Critical Mass Laboratory Valve Pit has not been
23 decommissioned.

24 3.6.3 Water Use

25
26
27 The 200 East Powerhouse Ditch is a man-made structure located along the
28 southern boundary of the Semi-Works Aggregate Area. This ditch receives discharge
29 water from the 200 East Powerhouse Facility. The water flows along the 760 m (2,500 ft)
30 ditch to a 100 cm (42 in) concrete pipe which directs the flow to the 216-B-3 Pond
31 Complex. The ditch has a bottom width of approximately 6 m (20 ft) and a depth of 3
32 m (10 ft). A more detailed discussion of the 200 East Powerhouse Ditch is presented in
33 Section 2.3.5.

34
35 There is no consumptive use of groundwater within the Semi-Works Aggregate
36 Area. Water for drinking and emergency use, and facilities process water is drawn from
37 the Columbia River, treated, and imported to the 200 East Area. The nearest wells used
38 to supply drinking water are located at the Yakima Barricade (Well 699-40-100-C) about
39 7 km (4 mi) west of the 200 East Area; at the Hanford Safety Patrol Training Academy
40 (Well 699-528-EO) about 40 km (24 mi) to the southeast; at the PNL Observatory (Well
41 6652-C); and near the Fast Flux Test Facility in the 400 Area (Well 699-S1-8J) about 32
42 km (19 mi) to the southeast. There are wells, specifically 299-E26-6, used by the 241-A

1 Tank Farm and two wells at the 282B and 282BA pump houses as an emergency water
2 supply for 200 East Area cooling systems. The nearest water supply wells located off-site
3 are about 15 km (9.4 mi) to the northwest (upgradient). These wells obtain their water
4 from the basalt and the basalt interbeds (the Berkshire Well and Chateau Ste. Michelle
5 No. 1 and No. 2). The latter wells are reportedly used for irrigation although they may
6 also be used to supply drinking water.

7 8 9 **3.7 HUMAN RESOURCES**

10
11 The environmental conditions at the Semi-Works Aggregate Area must be
12 evaluated in relationship to the surrounding population centers and other human
13 resources. A very brief summary of demography, archaeology, historical resources, and
14 community involvement is given below.

15 16 17 **3.7.1 Demography**

18
19 There are no residences on the Hanford Site. The nearest inhabited residences are
20 farm homes on land located 18 km (11 mi) north of the Semi-Works Aggregate Area.
21 There are approximately 411,000 people living within a 80 km (50 mi) radius of the 200
22 Areas Plateau based on the 1990 Census. The primary population centers are the cities
23 of Richland, Kennewick, and Pasco, located southeast of the Hanford Site, Prosser to the
24 south, Sunnyside to the southwest, and Benton City to the southeast.

25 26 27 **3.7.2 Archaeology**

28
29 An archaeological survey has been conducted of undeveloped portions of the 200
30 East Area by the Hanford Cultural Resources Laboratory. Isolated artifacts and sites of
31 interest were identified in the 200 West Area but not within the Semi-Works Aggregate
32 Area. The closest site of interest is the remains of the White Bluffs Road, located
33 approximately 15 km (9 mi) northwest of the aggregate area, which was previously an
34 Indian trail.

35 36 37 **3.7.3 Historic Resources**

38
39 The only historic site near 200 East Area is the old White Bluffs Road which
40 crosses diagonally through the vicinity of the 200 West Area. This site is not considered
41 to be eligible for the National Register.
42

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3.7.4 Community Involvement

A Community Relations Plan (Ecology et al. 1989) has been developed for the Hanford Site Environmental Restoration Program that includes any potentially affected community with respect to the Semi-Works AAMS. The Community Relations Plan includes a discussion on analysis of key community concerns and perceptions regarding the project, along with a list of all interested parties.

9 3 1 2 8 8 9 0 1 4 8

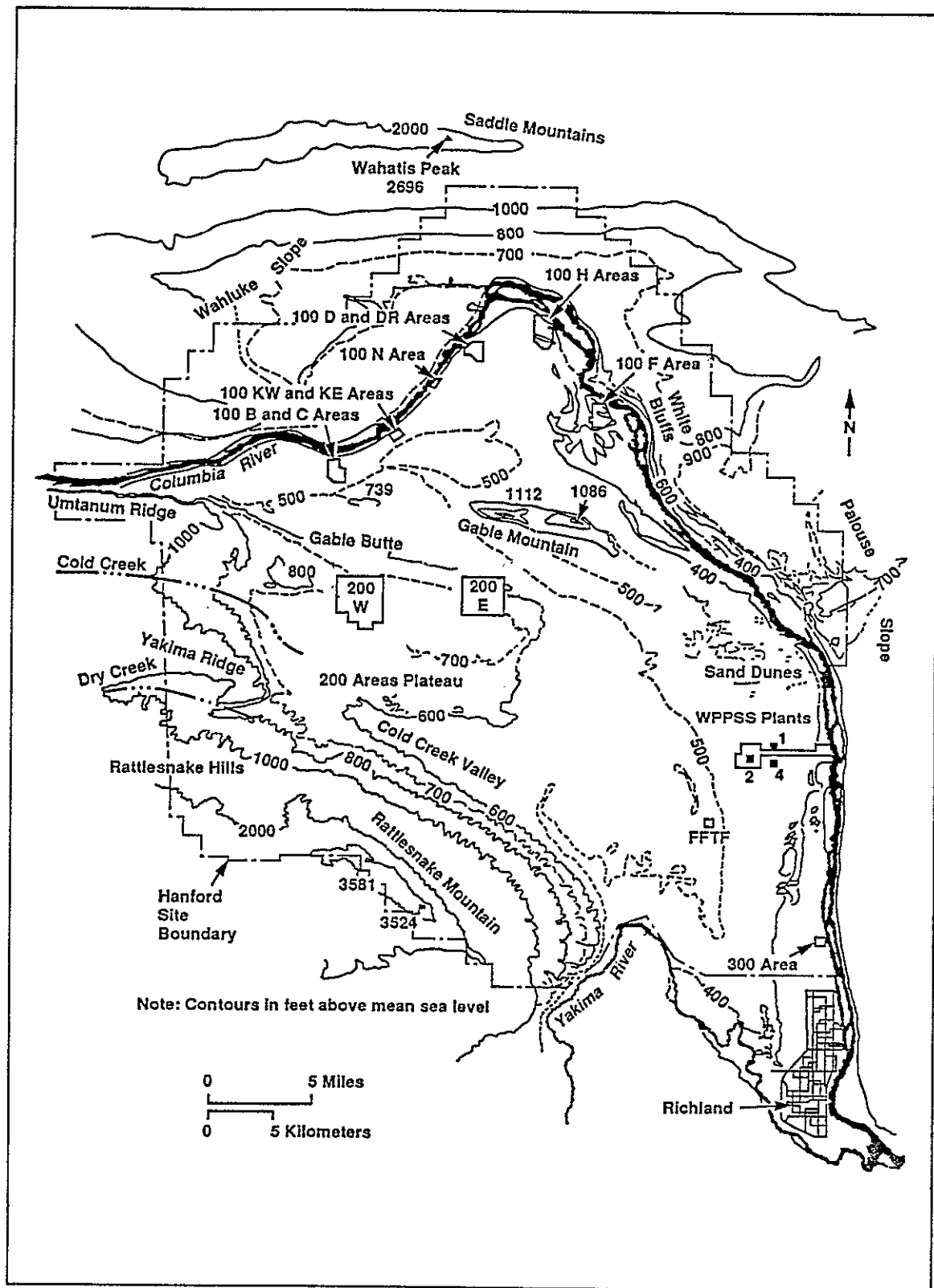


Figure 3-1. Topography and Location Map for the Hanford Site.

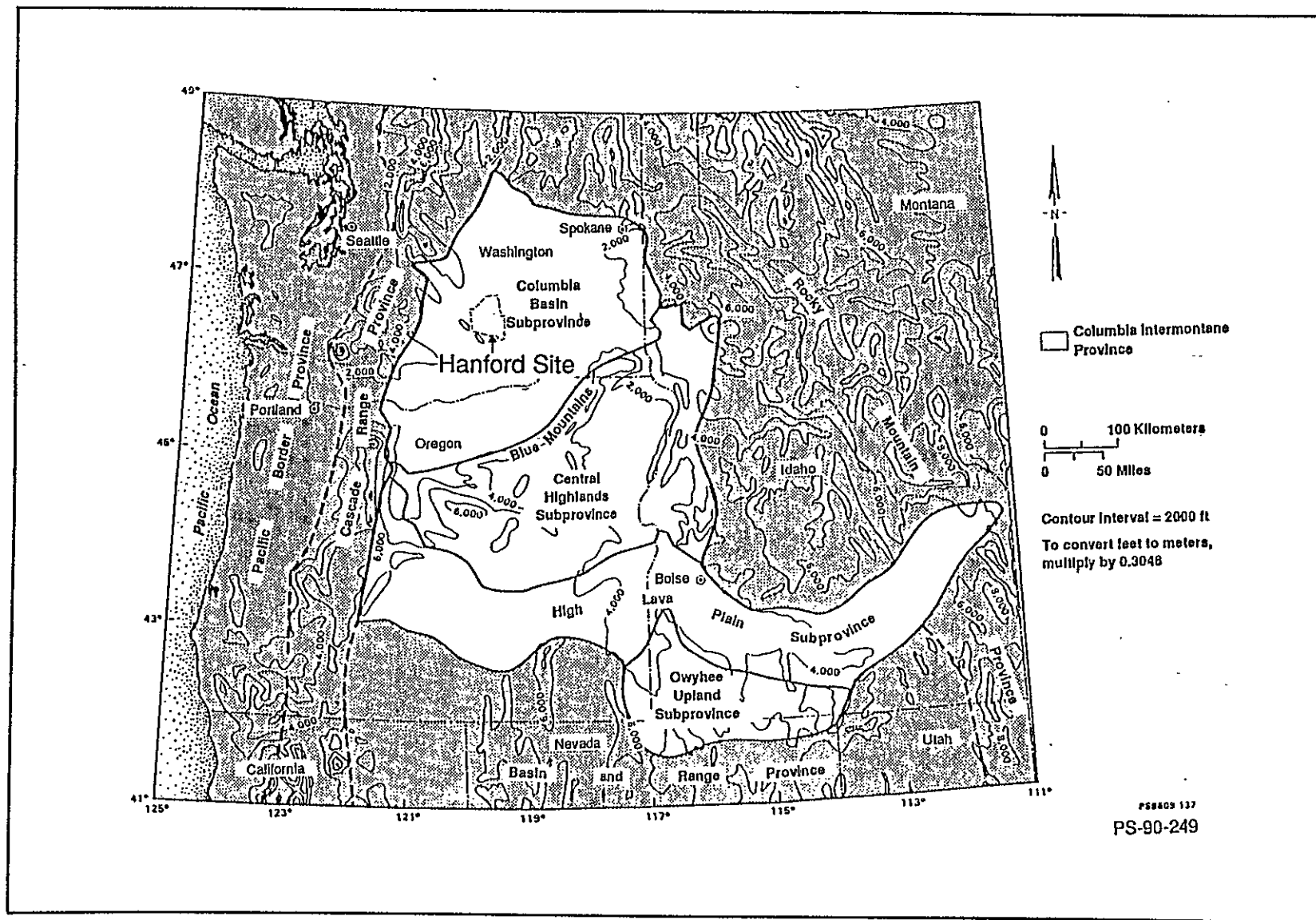


Figure 3-2. Divisions of the Columbia Intermontane Province and Adjacent Snake River Plains Province (DOE 1988a).

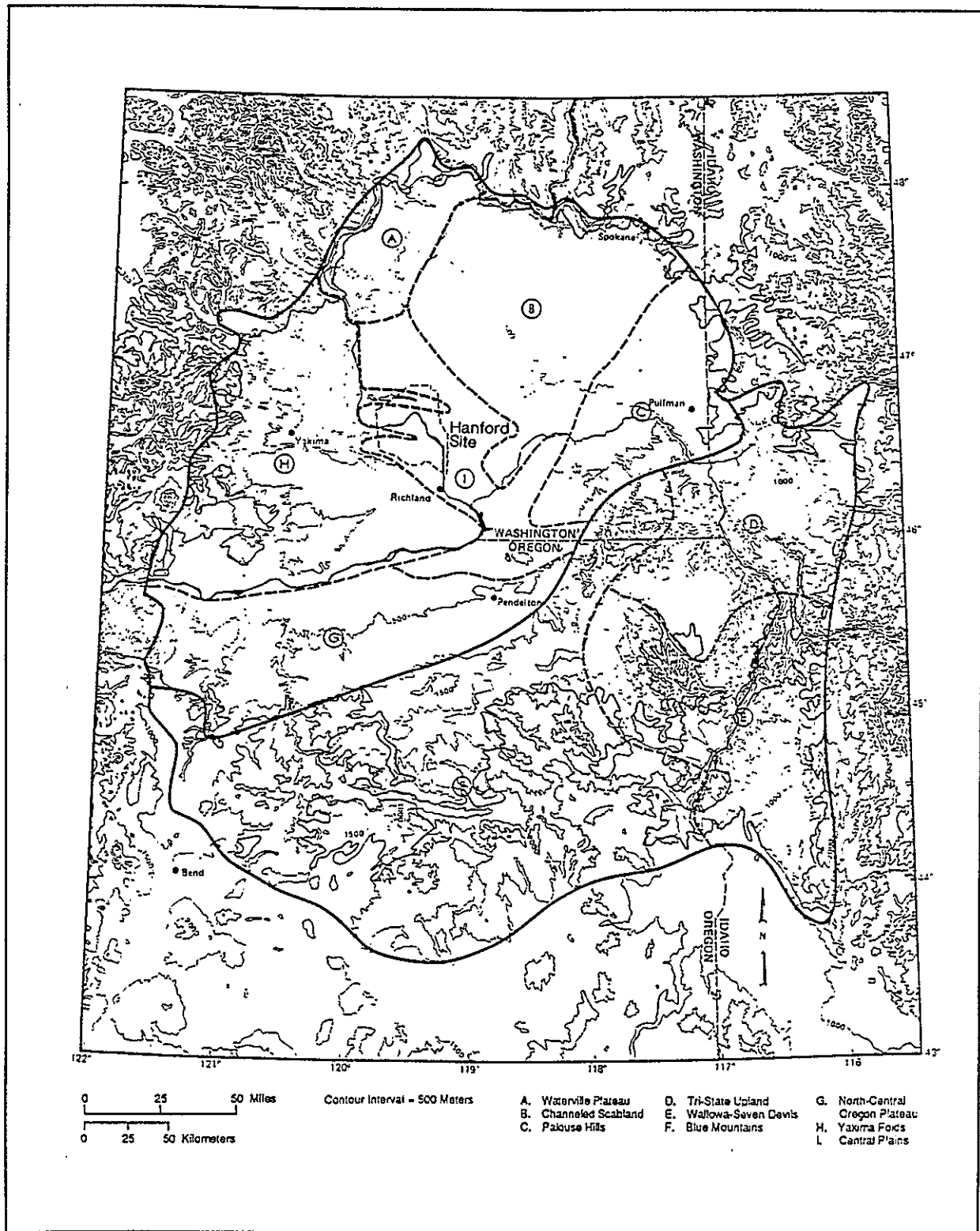


Figure 3-3. Geomorphic Units Within the Central Highlands and Columbia Basin Subprovinces that Contain the Columbia River Basalt Group (DOE 1988a).

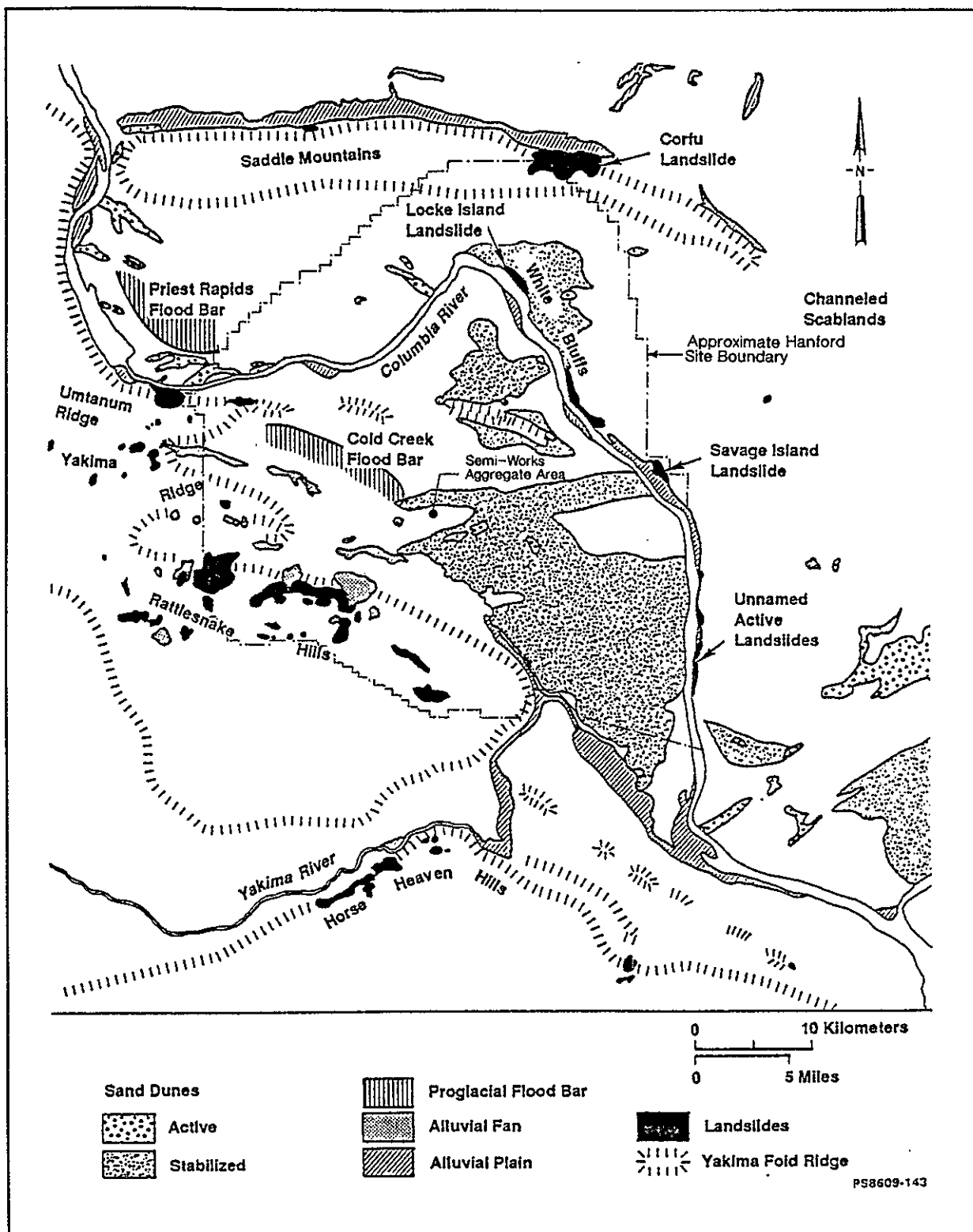


Figure 3-4. Landforms of the Pasco Basin and the Hanford Site (DOE 1988a).

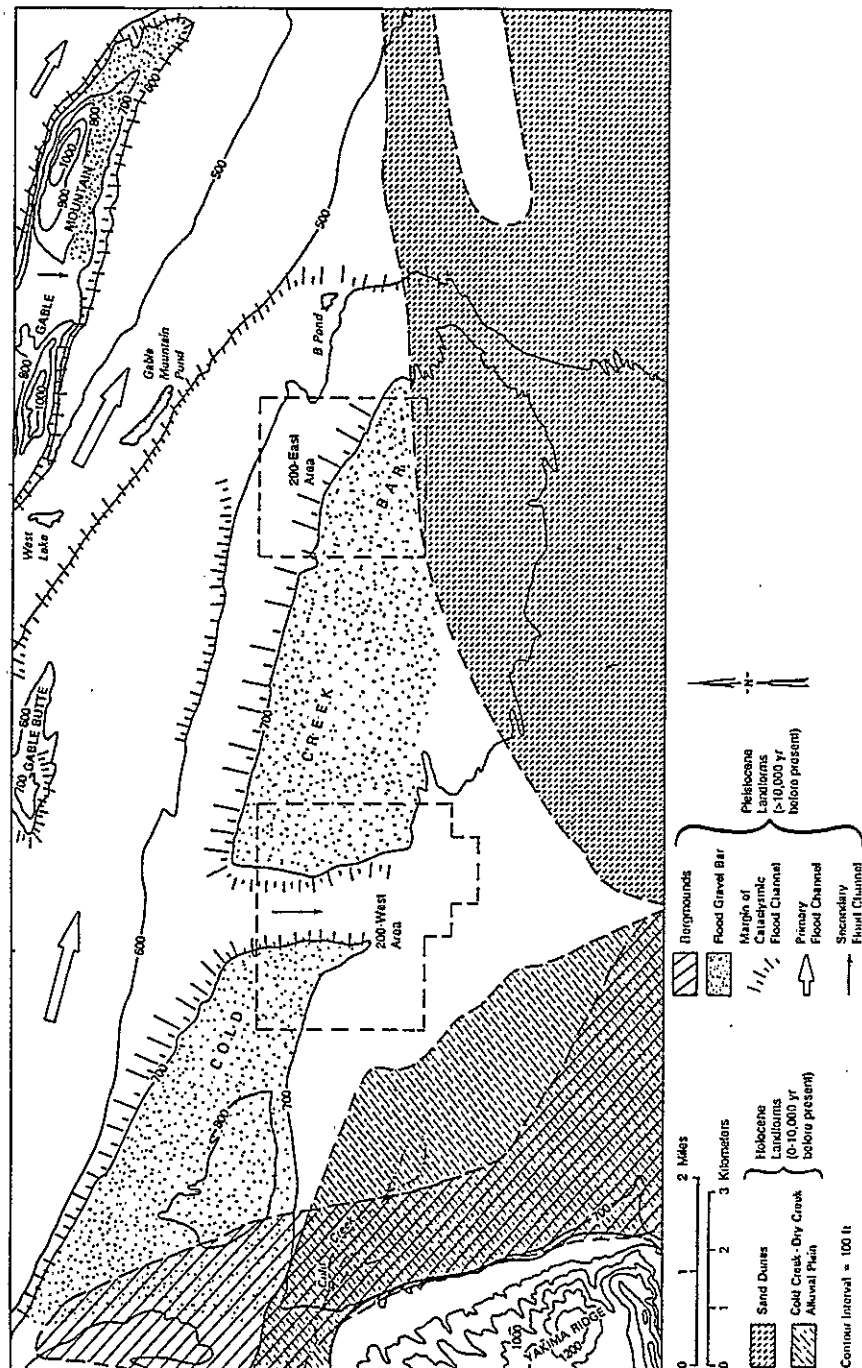


Figure 3-5. Geomorphic Features Surrounding the 200 Areas (DOE 1988a).

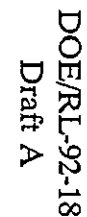


Figure 3-6. Topographic Map of Semi-Works Aggregate Area.

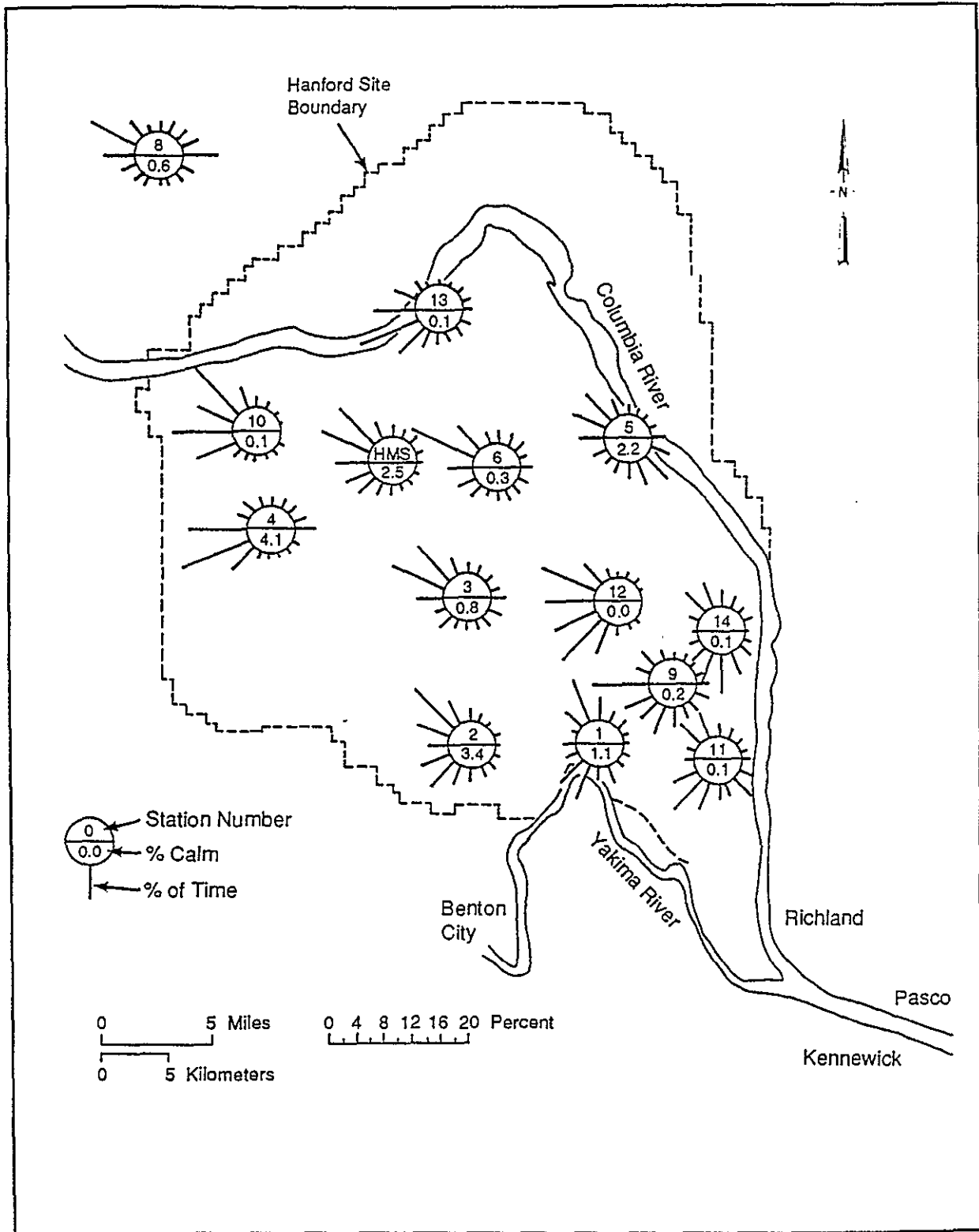


Figure 3-7. Hanford Site Wind Roses, 1979 through 1982 (Stone et al. 1983).

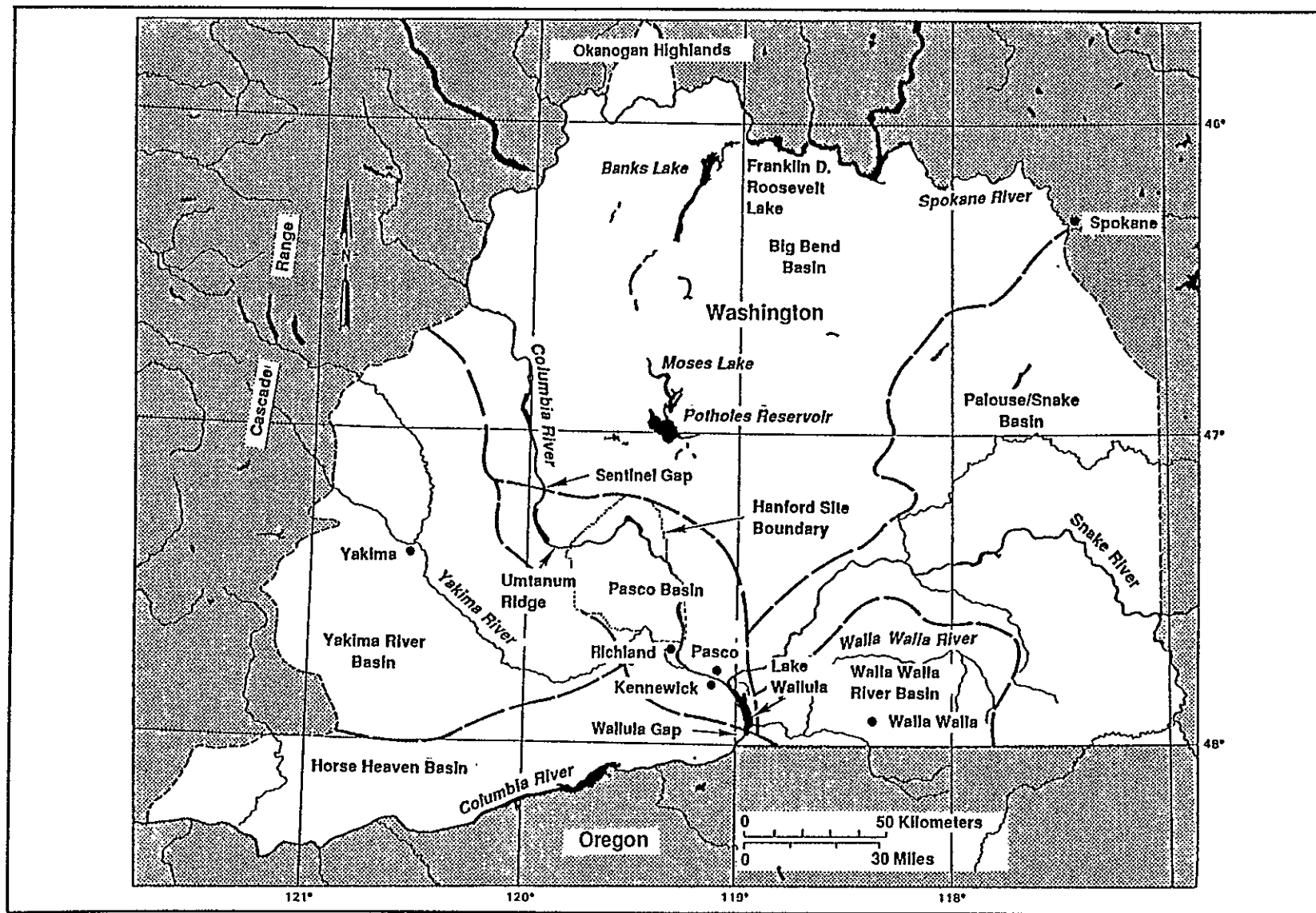
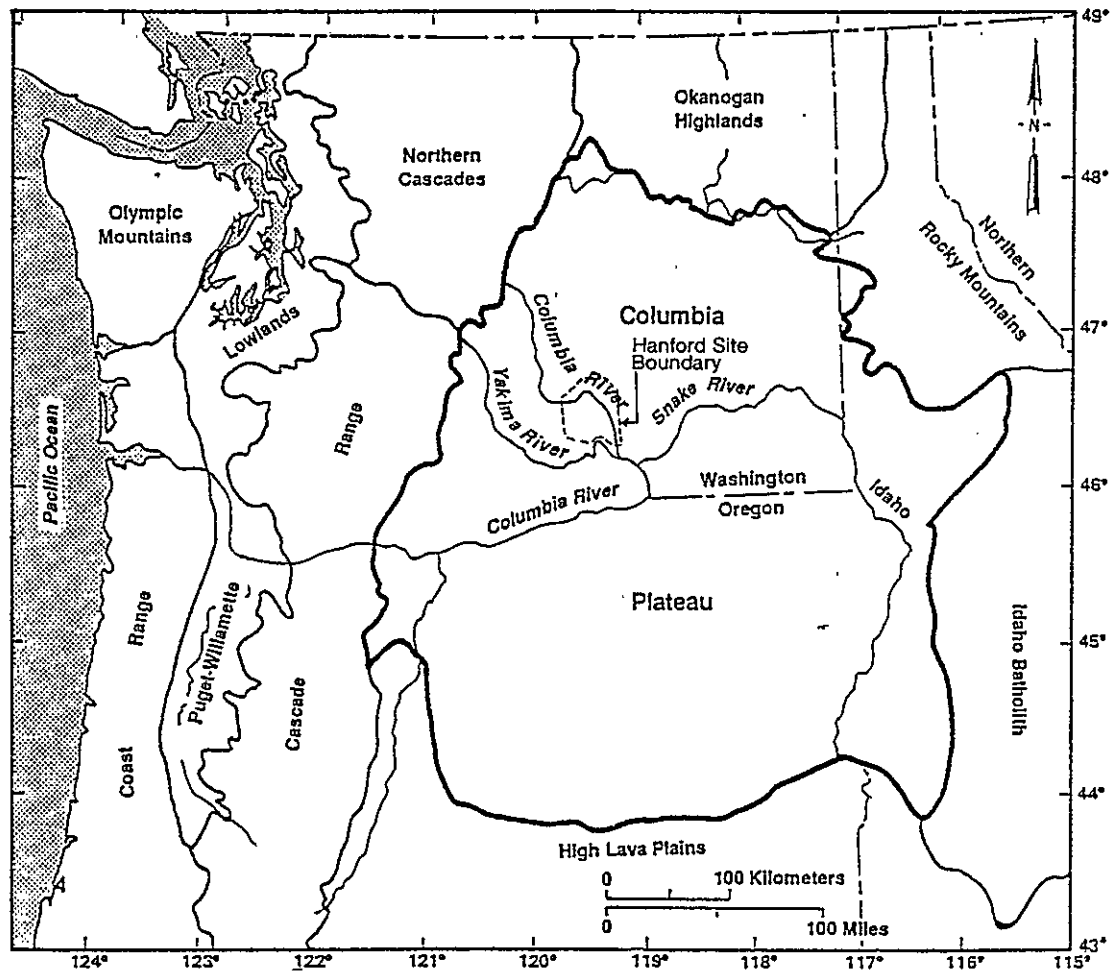


Figure 3-8. Hydrologic Basins Designated for the Washington State Portion of the Columbia Plateau (DOE 1988a).



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PS-90-248

Figure 3-9. Structural Provinces of the Columbia Plateau.

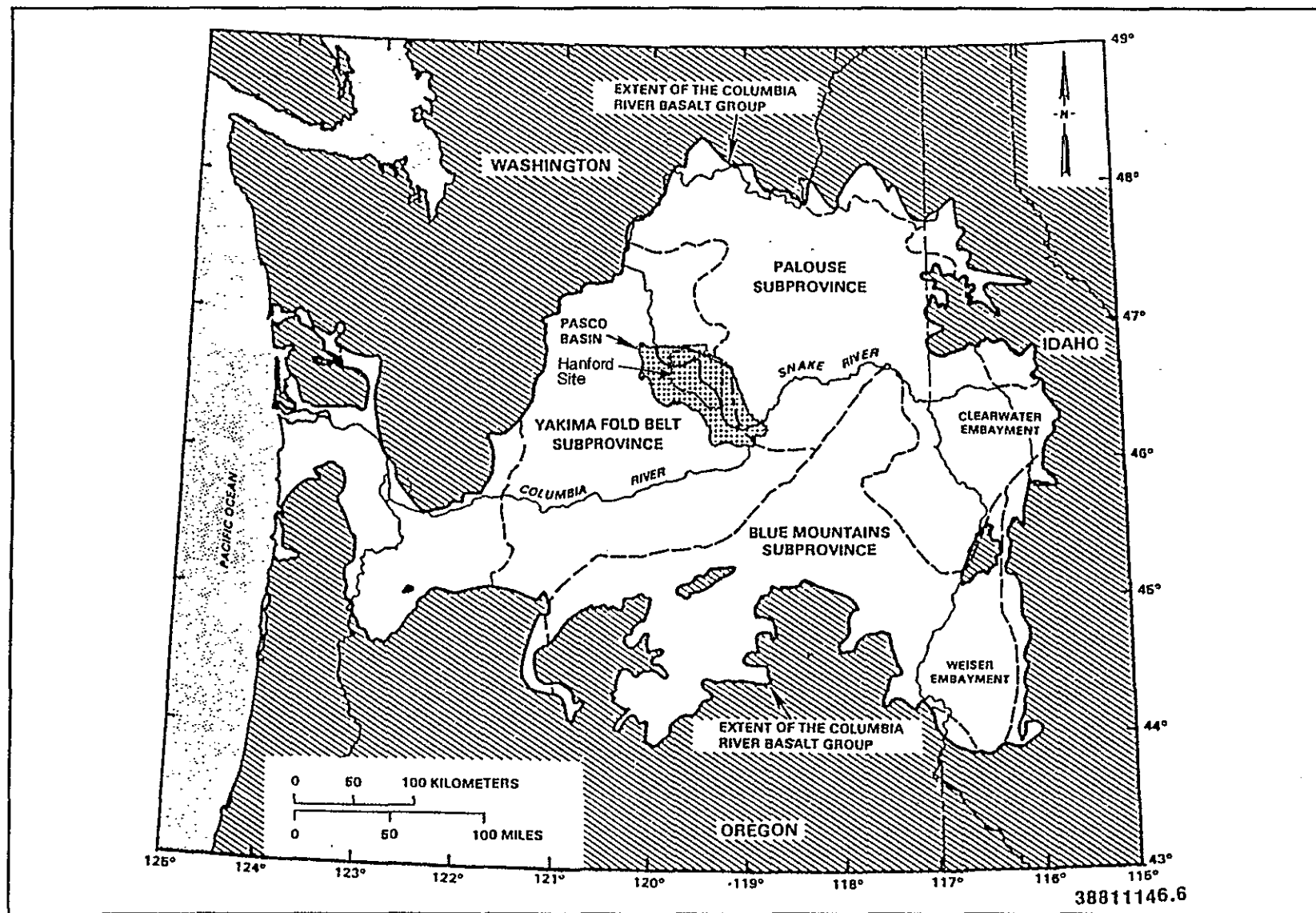
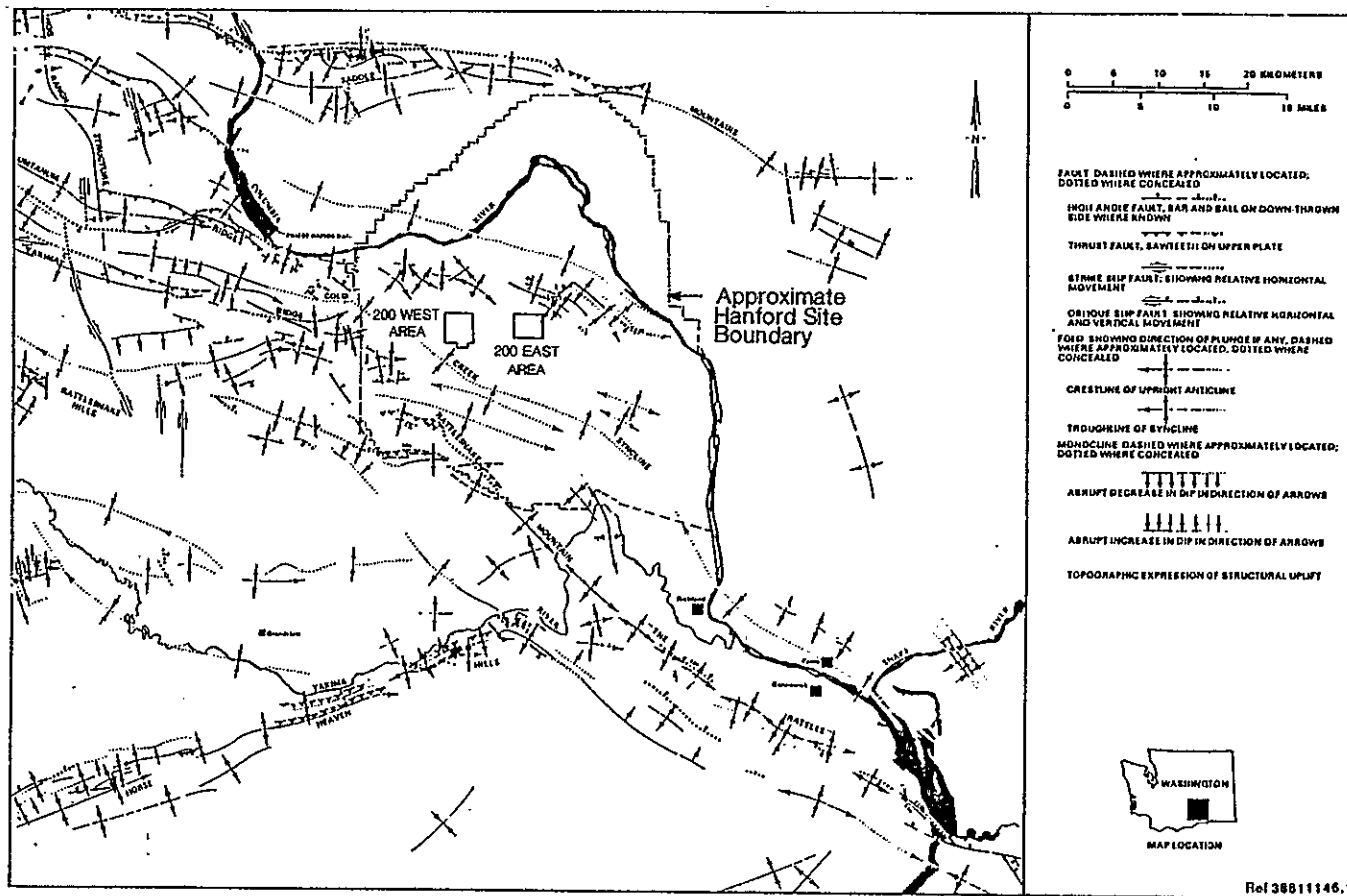


Figure 3-10. Structural Subprovinces of the Columbia Plateau (DOE 1988a).



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Figure 3-11. Structural Elements of the Yakima Fold Belt Subprovince (DOE 1988a).

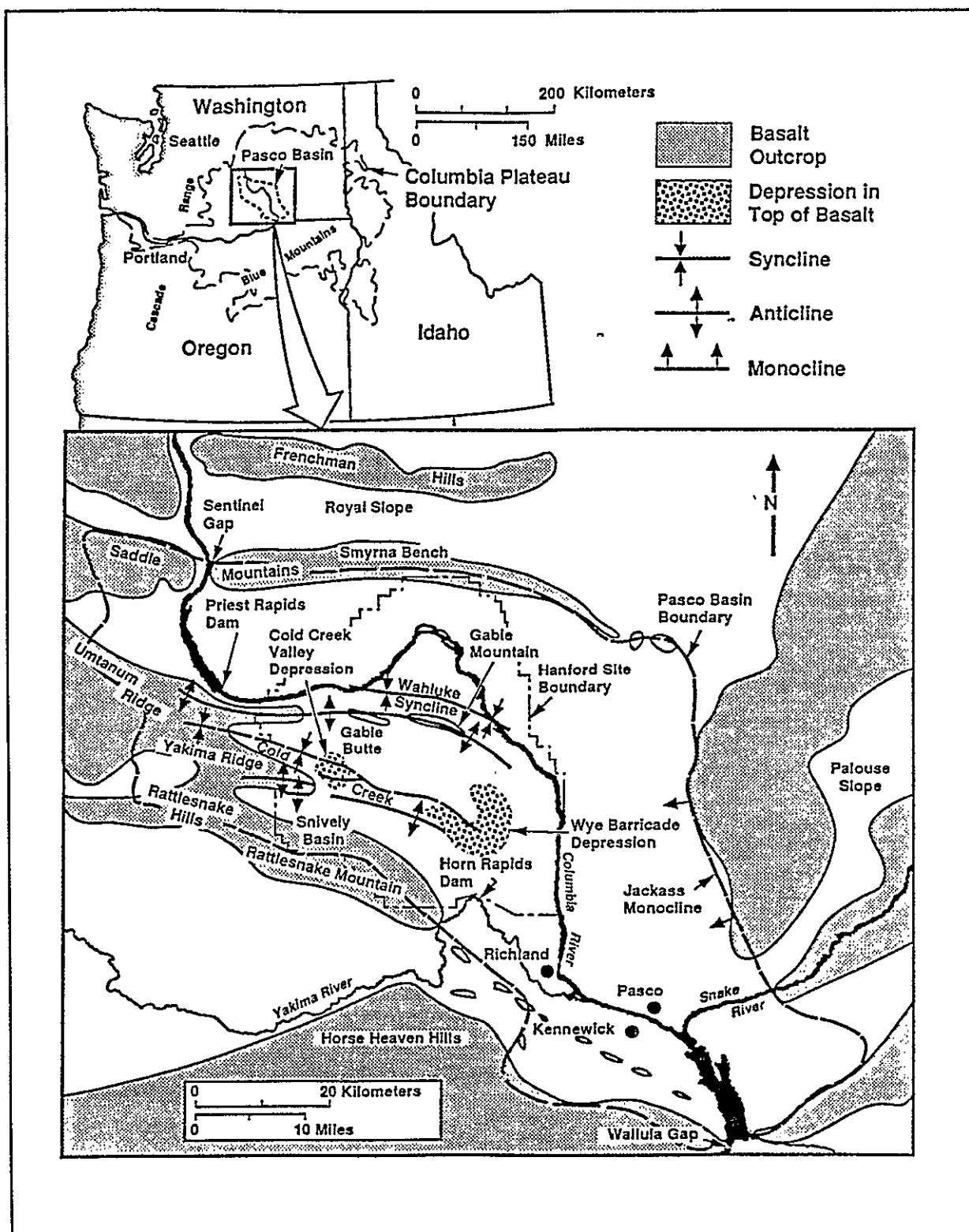


Figure 3-12. Geologic Structures of the Pasco Basin and the Hanford Site (Reidel et al. 1989a).

Period		QUATERNARY		Group	Formation	Isotopic Age Dates Years x 10 ⁶	Member (Formal and Informal)	Sediment Stratigraphy or Basalt Flows	
Epoch	Pliocene	Pleistocene	Holocene						
TERTIARY	Miocene	Columbia River Basalt Group	Ringold	Hanford			Surficial Units	Loess Sand Dunes Alluvium and Alluvial Fans Land Slides Talus Colluvium	
							Touchet beds		
							Pasco gravels		
								Plio-Pleistocene unit	
							8.5	Ice Harbor Member	basalt of Goose Island
									basalt of Martindale
									basalt of Basin City
									Levey interbed
							10.5	Elephant Mountain Member	basalt of Ward Gap
									basalt of Elephant Mountain
							12.0	Pomona Member	Rattlesnake Ridge interbed
									basalt of Pomona
								Esquatzel Member	Selah interbed
									basalt of Gable Mountain
							13.5	Asotin Member	Cold Creek interbed
									basalt of Huntzinger
								Wilbur Creek Member	basalt of Lapwai
									basalt of Wahluke
								Umatilla Member	basalt of Siltusi
									basalt of Umatilla
							14.5	Priest Rapids Member	Mabton interbed
									basalt of Lolo
								Roza Member	basalt of Rosalia
									Quincy interbed
								Frenchman Springs Member	basalt of Roza
									Squaw Creek interbed
									basalt of Lyons Ferry
									basalt of Sentinel Gap
									basalt of Sand Hollow
	basalt of Silver Falls								
	basalt of Ginkgo								
15.6	Sentinel Bluffs Unit	basalt of Palouse Falls							
		Vantage interbed							
		basalt of Museum							
		basalt of Rocky Coulee							
		basalt of Levering							
		basalt of Cohasset							
		basalt of Birkett							
16.5	Umtanum Unit	basalt of McCoy Canyon							
		basalt of Umtanum							
	Ortley Unit	basalt of Benson Ranch							
	Grouse Creek Unit								
	Wapshilla Ridge Unit								
	Mt. Hornblé Unit								
	China Creek Unit								
	Teepees Butte Unit								
	Buckhorn Springs Unit								
17.5	Rock Creek Unit								
		American Bar Unit							

Ebensburg Formation

*The Grande Ronde Basalt consists of at least 120 major basalt flows. Only a few flows have been named. N₂, R₂, N₁ and R₁ are magnetostratigraphic units.

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Figure 3-13. Generalized Stratigraphy of the Hanford Site.

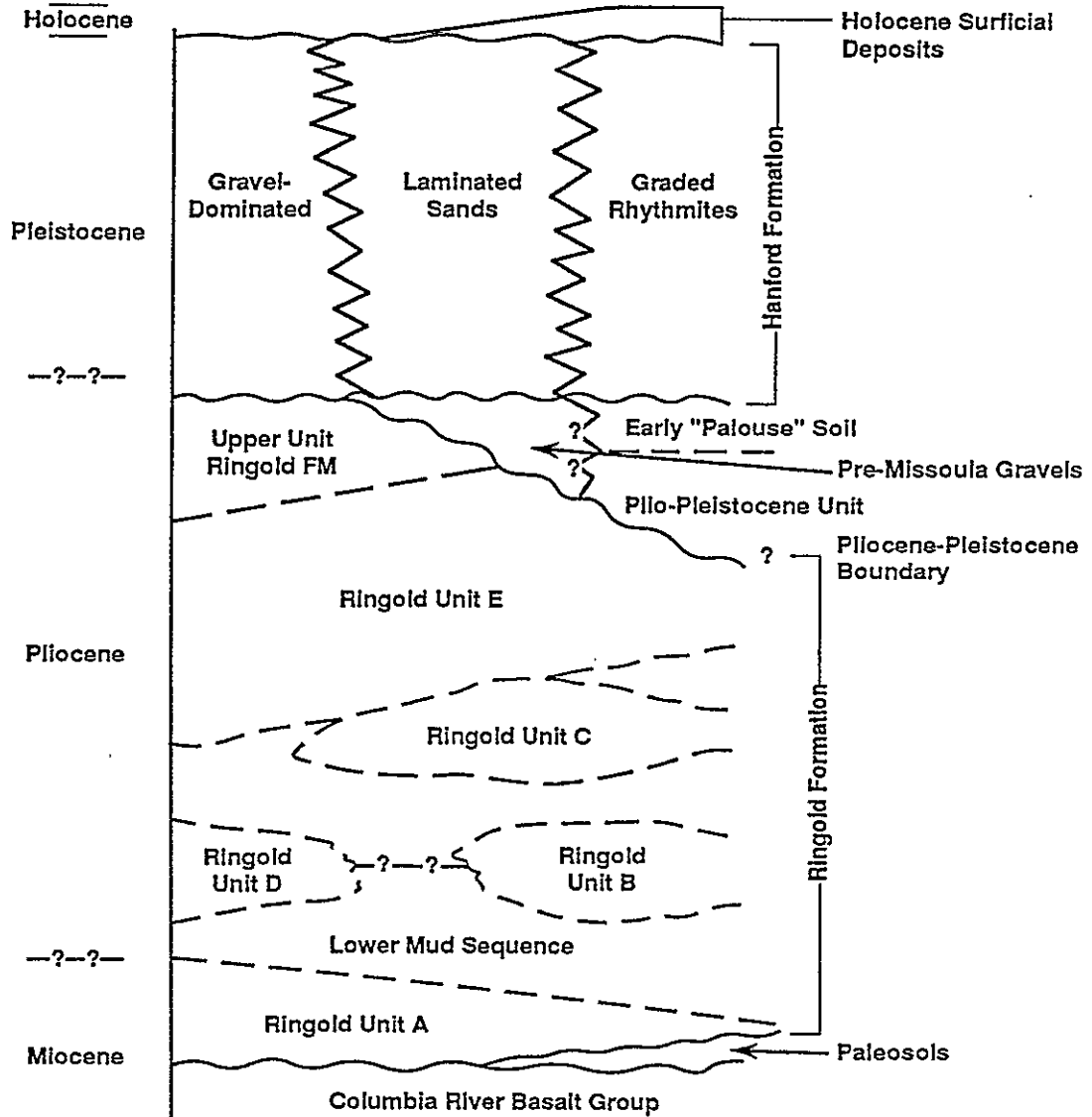


Figure 3-14. Generalized Stratigraphy of the Suprabasalt Sediments Beneath the Hanford Site (Lindsey and Gaylord 1989).

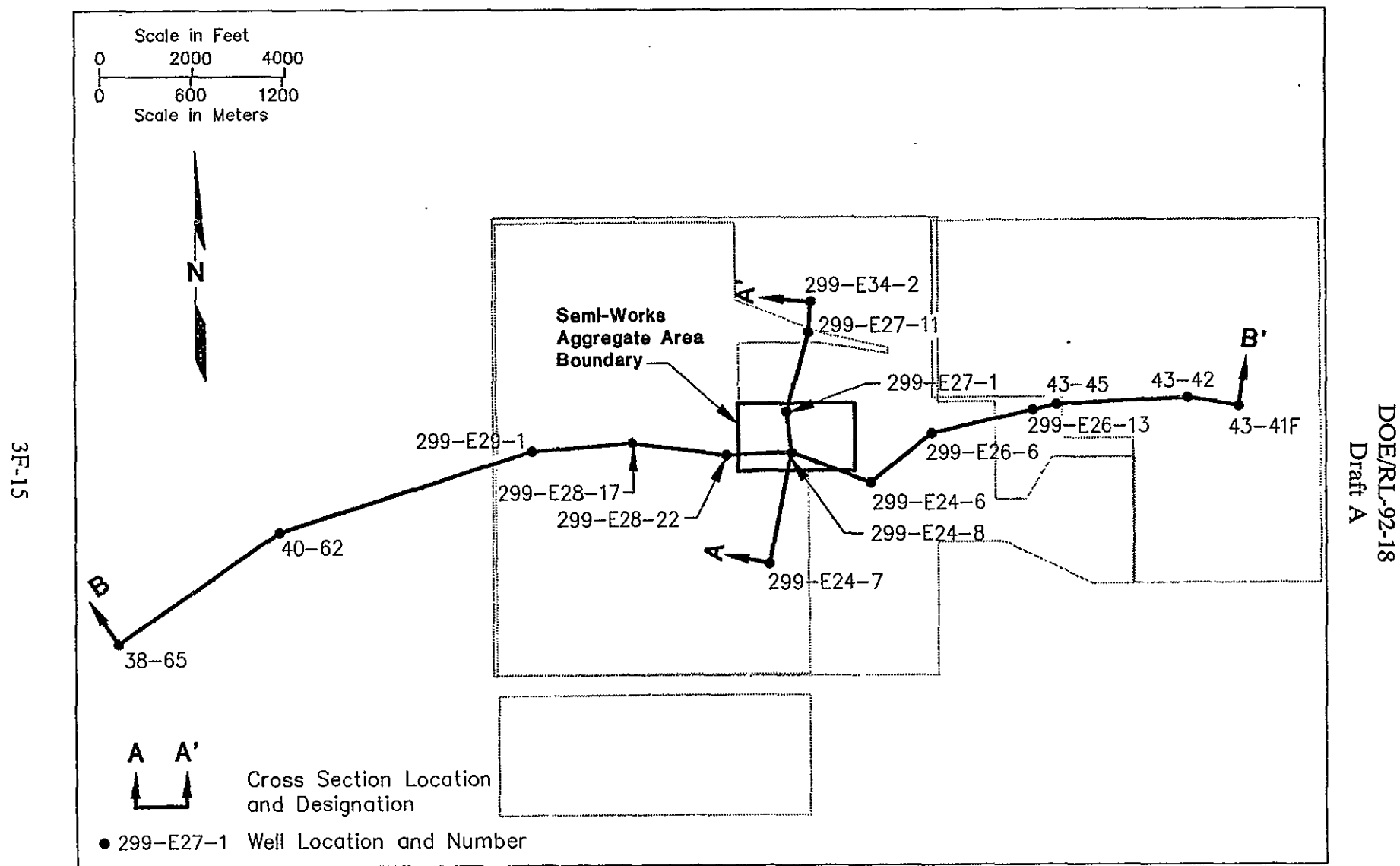


Figure 3-15. Location of the Cross Sections.

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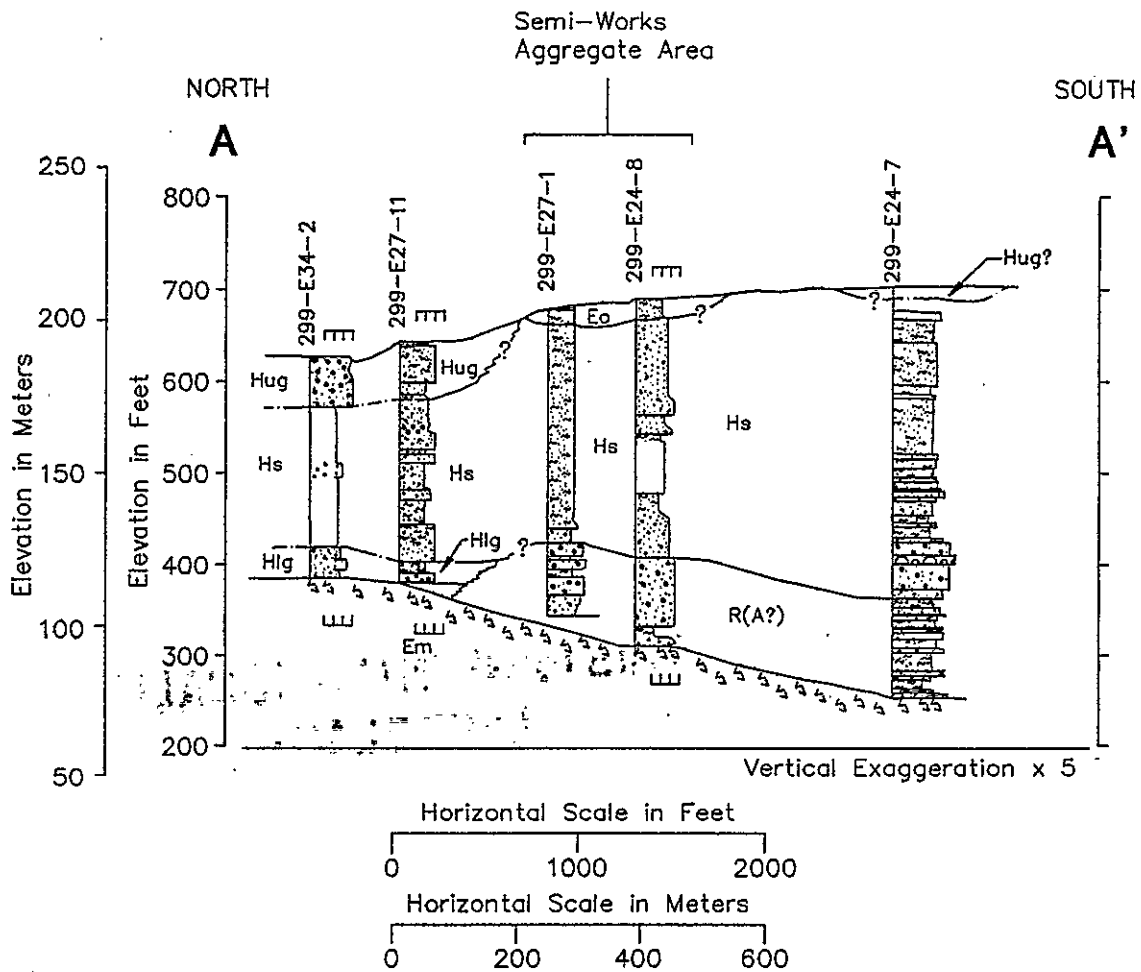
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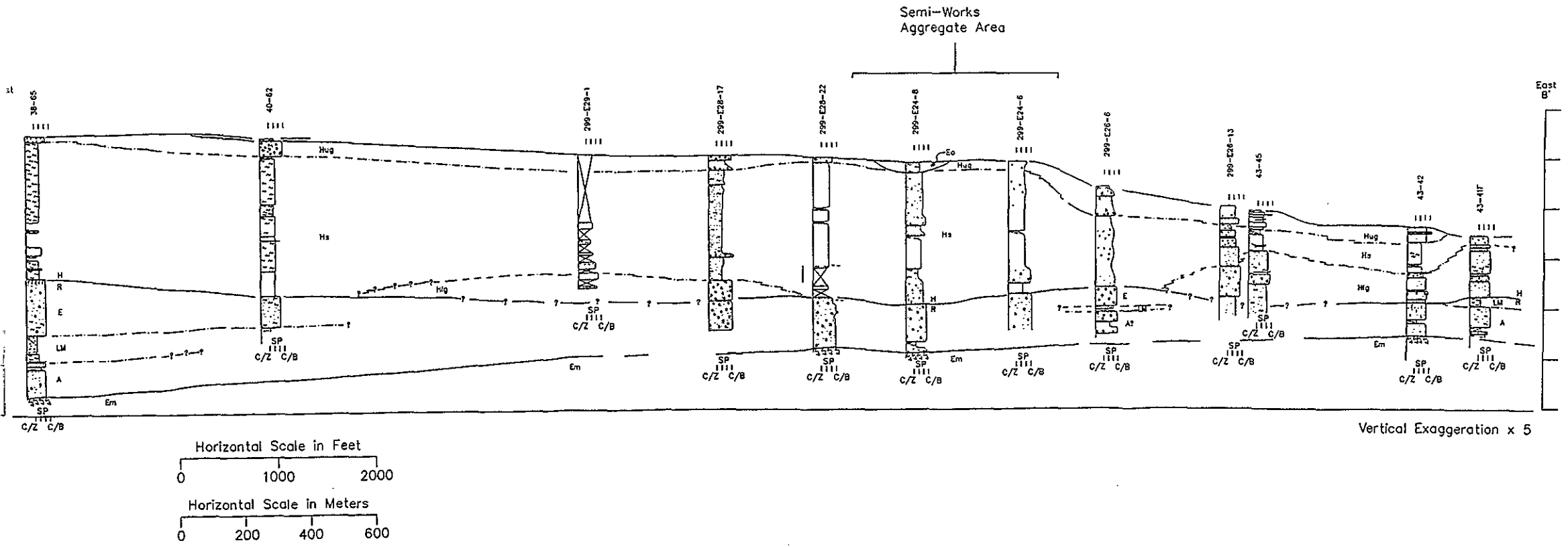
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Note:

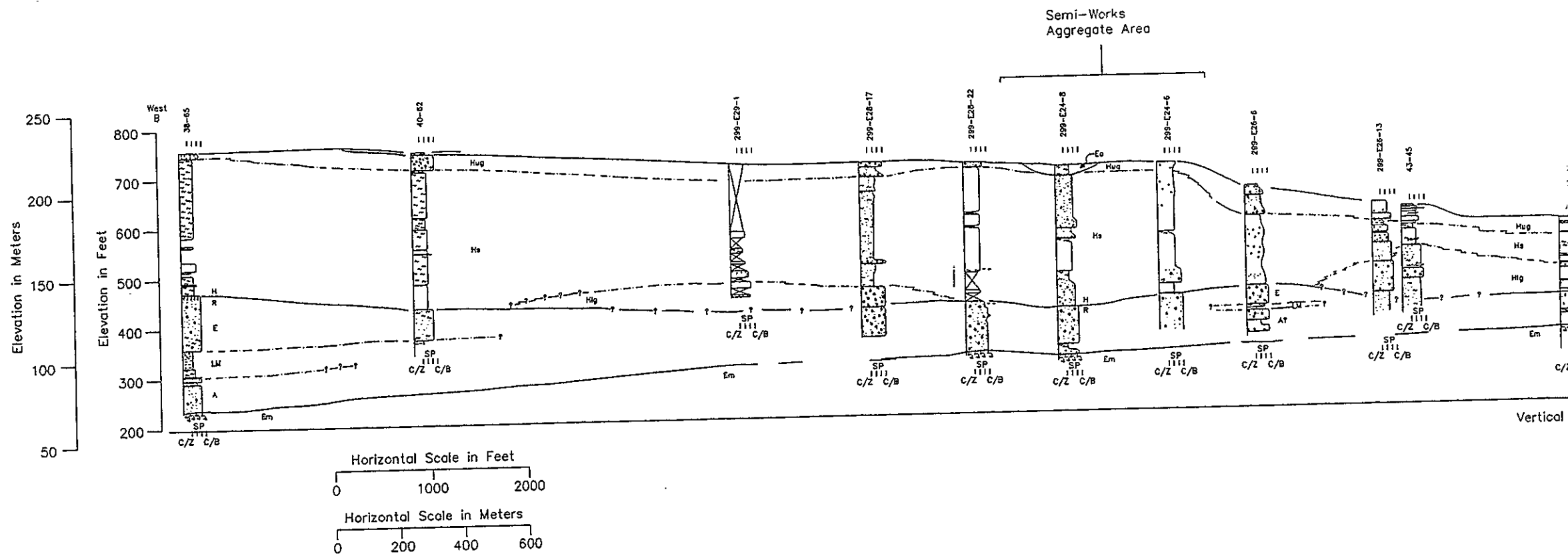
Based on borehole information from Chamness et al. (1992) and Lindsey et al. (1992). Refer to Figure 3-15 for cross section location and Figure 3-16 for legend.

Figure 3-17. Geologic Cross Section A-A'.



il. (1992)
for Cross-Section location and Figure 3-16 for Legend.

Figure 3-18. Geologic Cross Section B-B'.



Note:

Based on Lindsey et al. (1992)
Refer to Figure 3-15 for Cross-Section location and Figure 3-16 for Legend.

Figure 3-18.

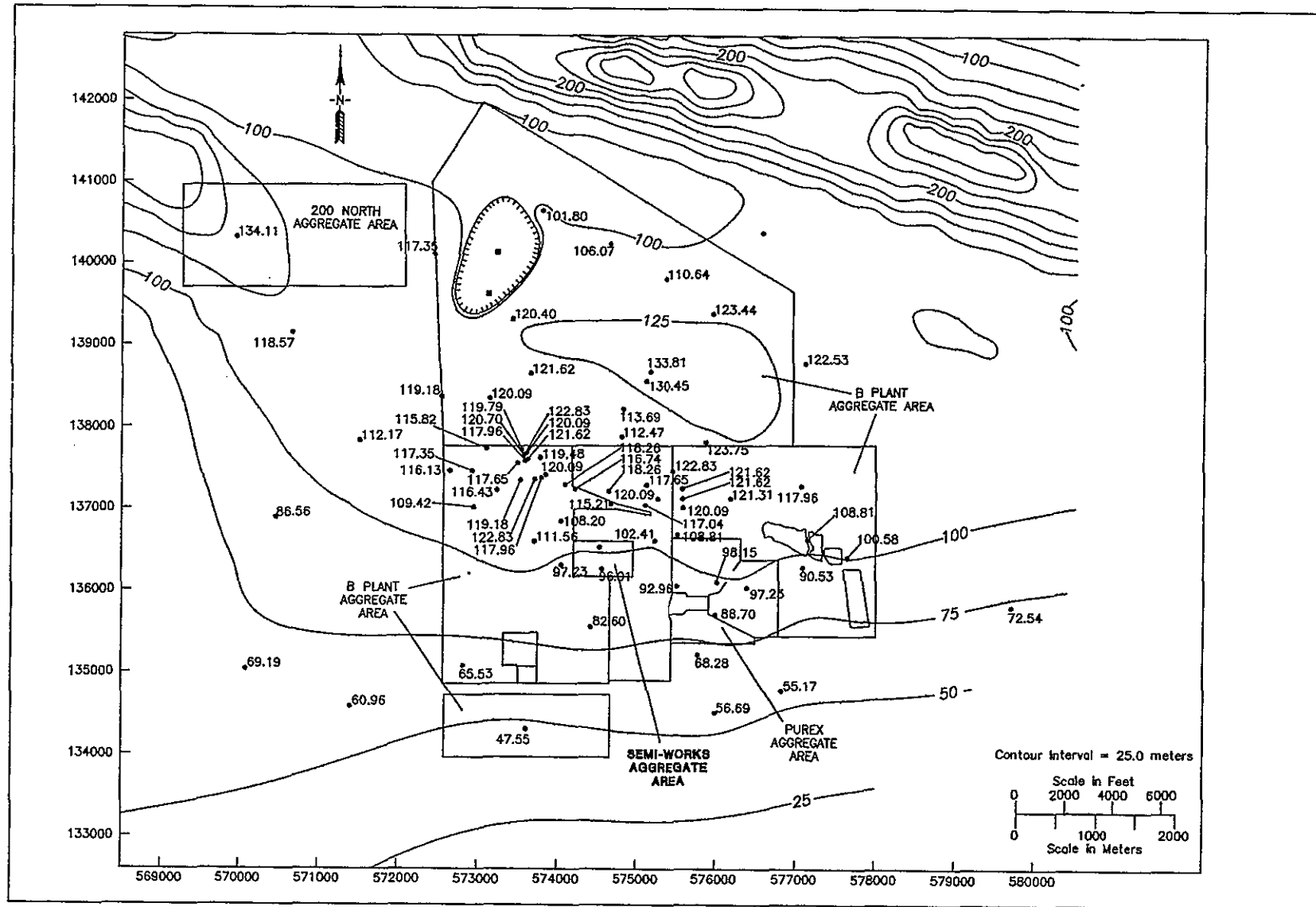


Figure 3-19. Structure Contour Map of Surface of the Elephant Mountain member beneath 200 East Area.

3F-20

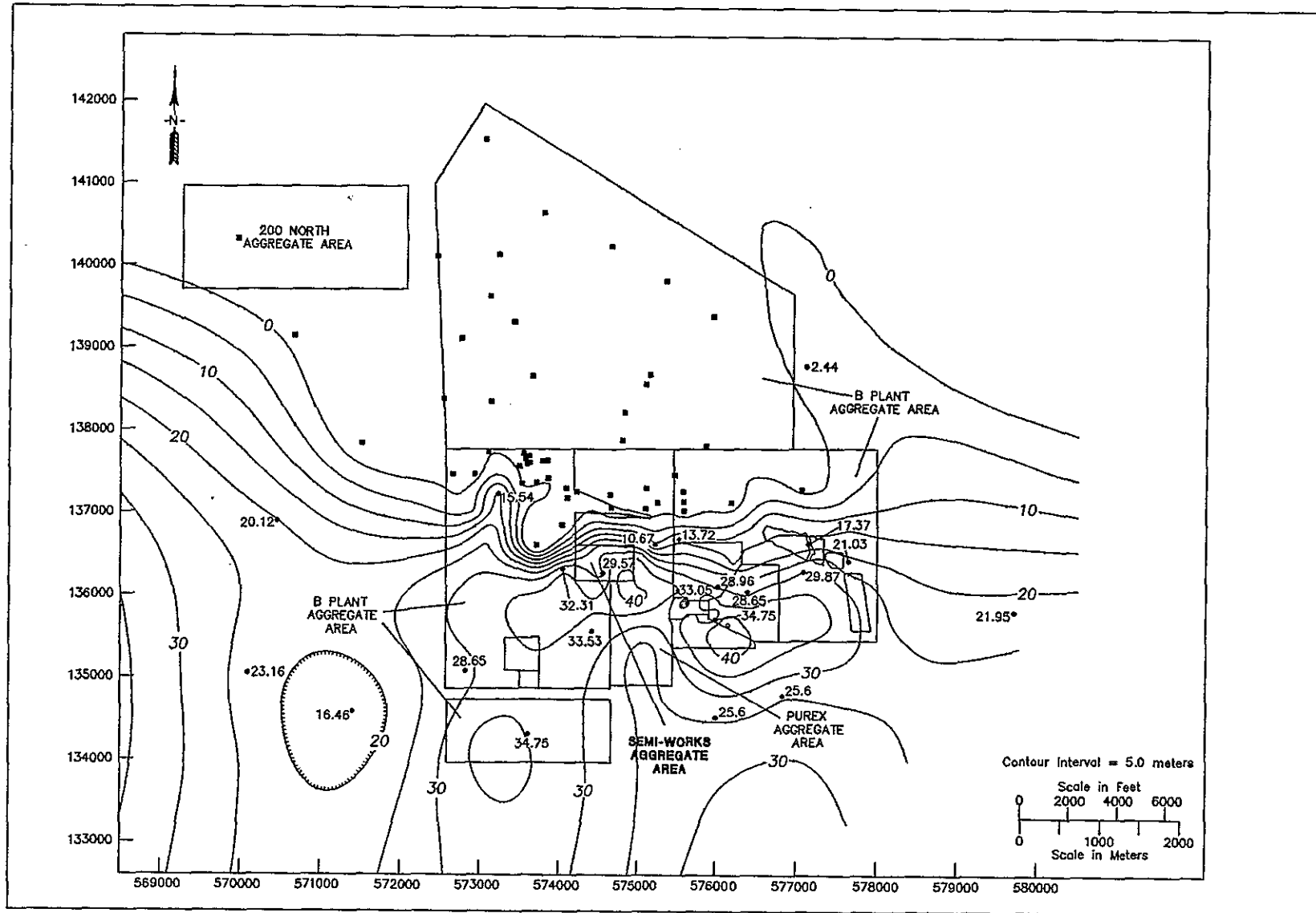
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Figure 3-20. Isopach Map of the Ringold Gravel Unit A.

3F-21

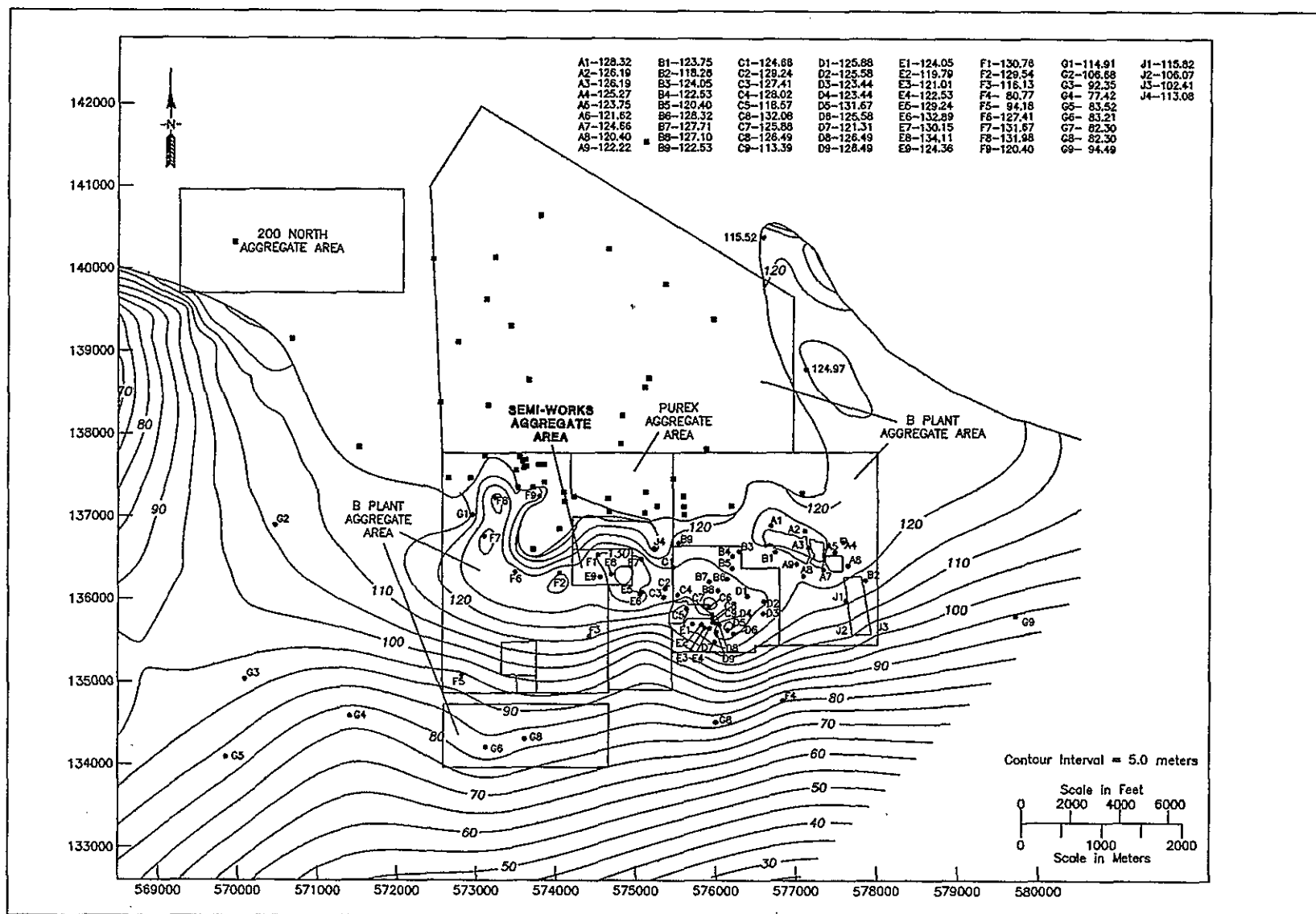
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Figure 3-21. Structure Contour Map of the Top of the Ringold Gravel Unit A.

3F-22

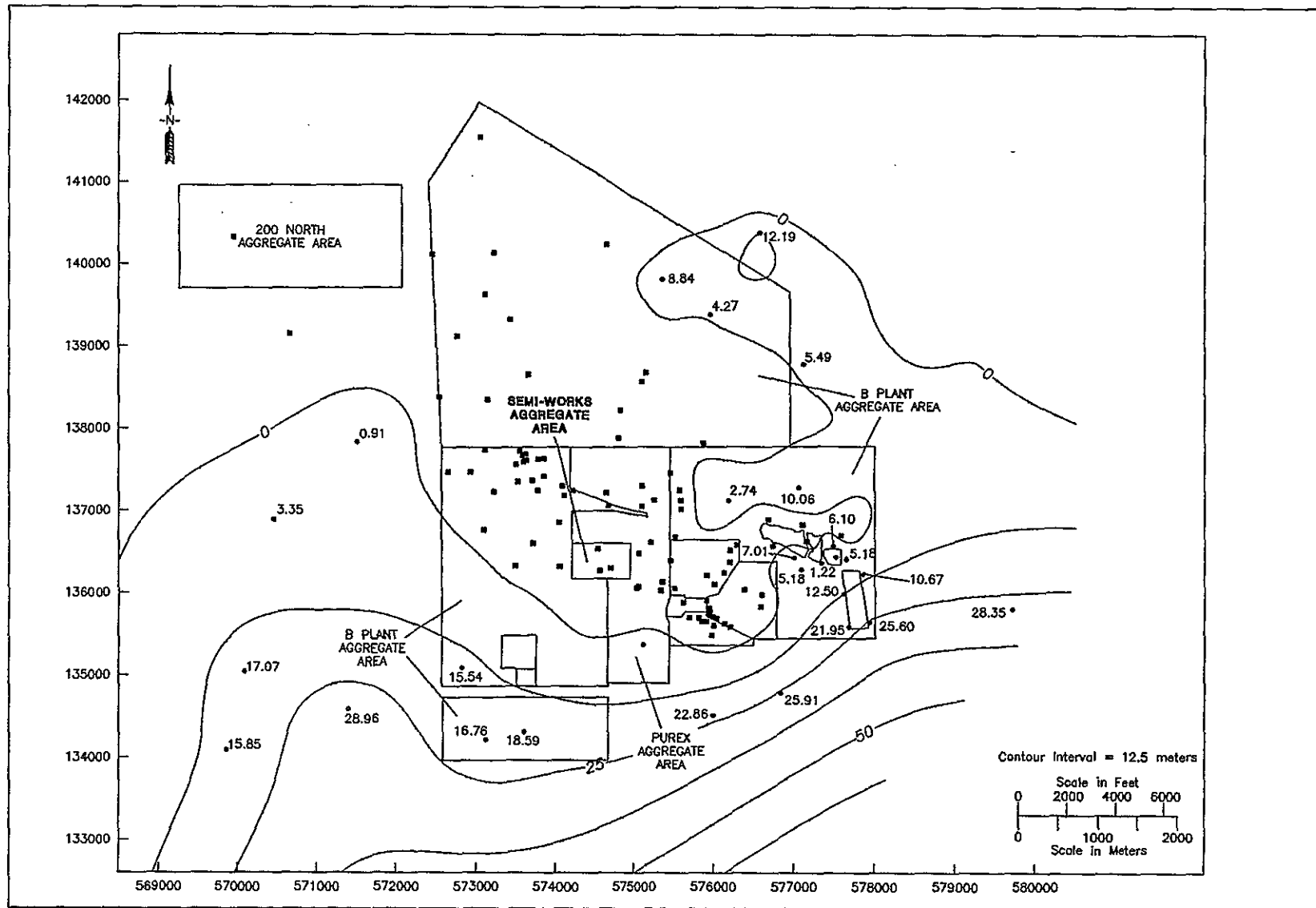
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Figure 3-22. Isopach Map of the Lower Mud Sequence, Ringold Formation.

3F-23

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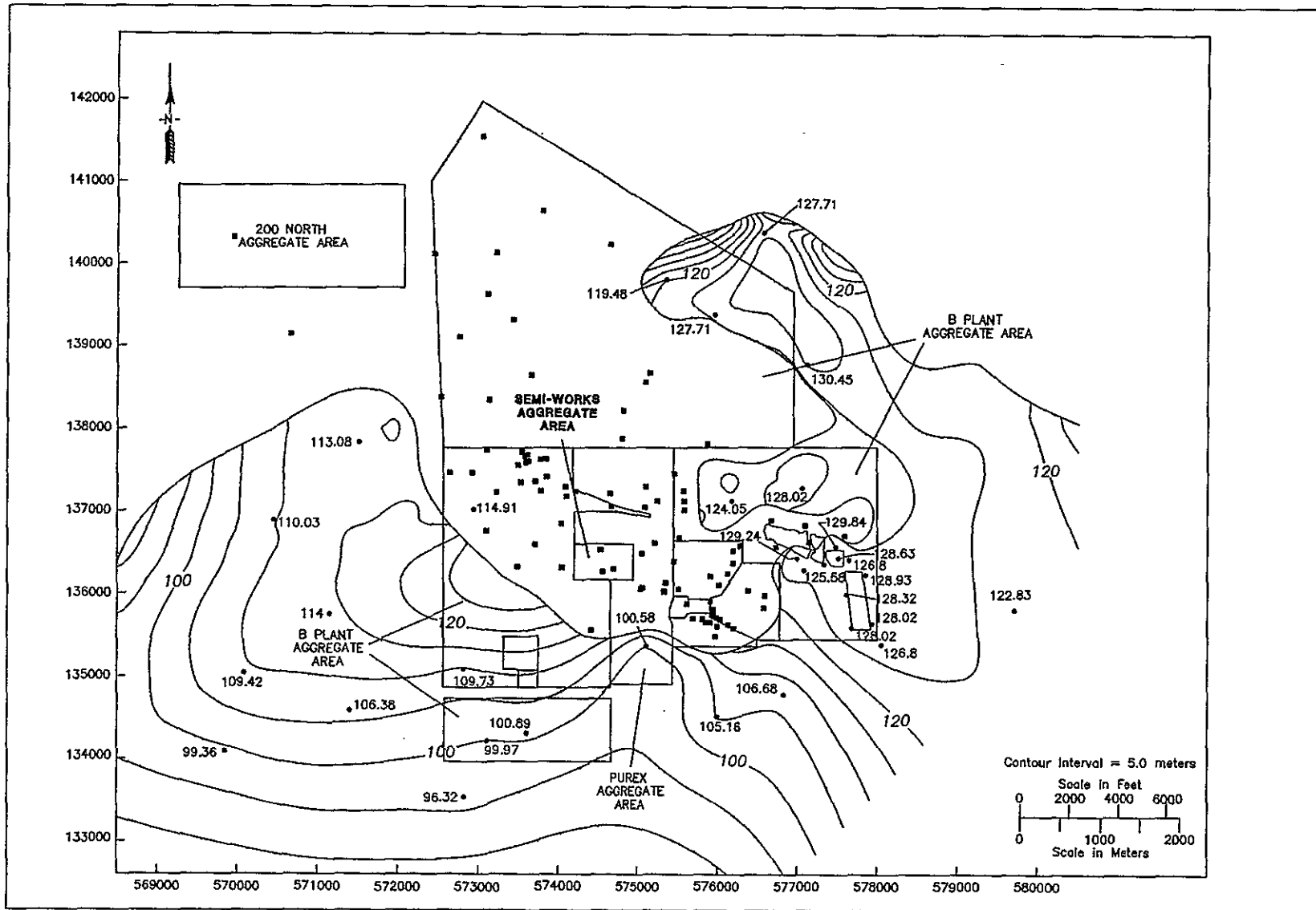


Figure 3-23. Structure Contour Map of the Top of the Lower Mud Sequence, Ringold Formation.

3F-24

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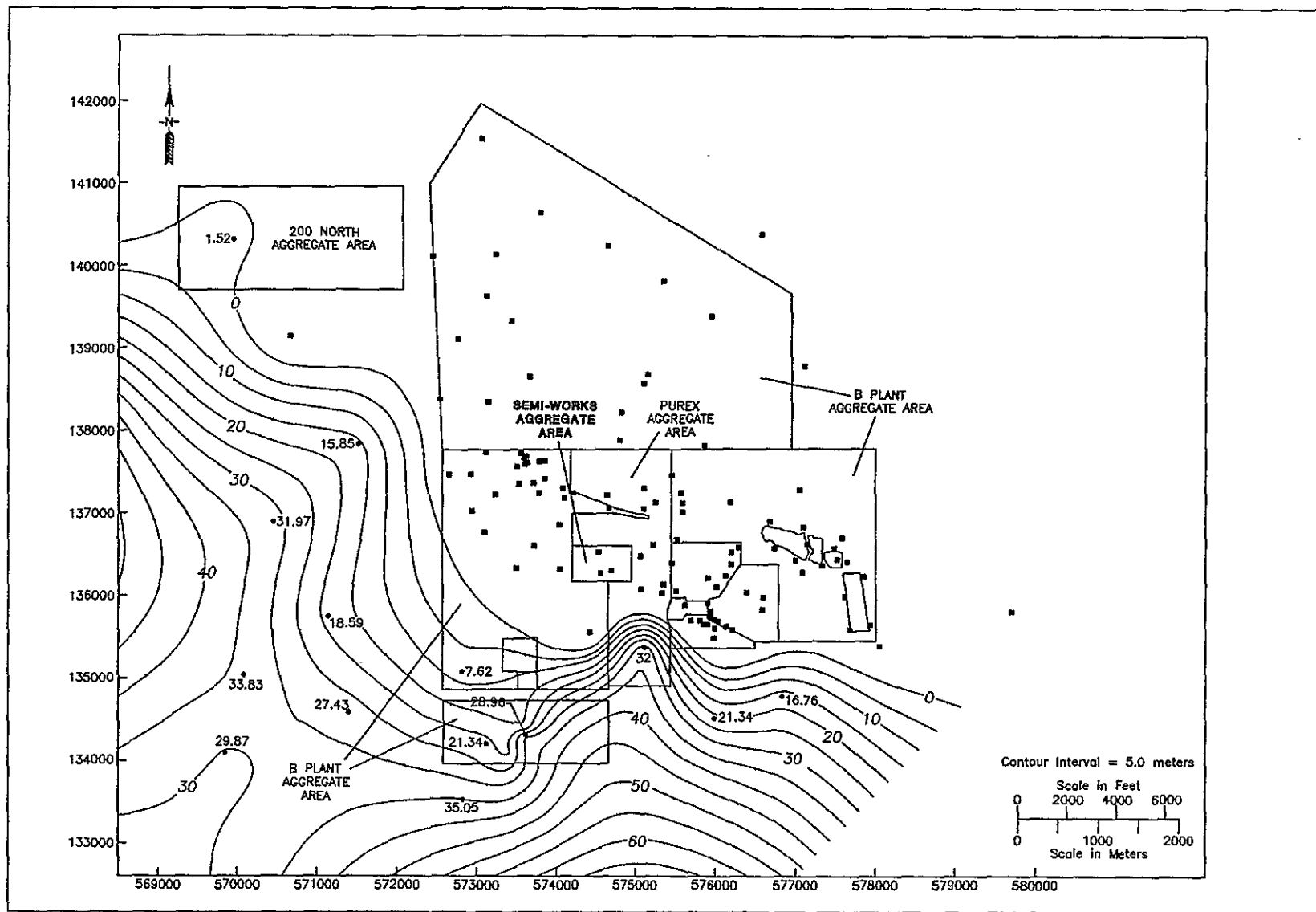


Figure 3-24. Isopach Map of the Ringold Gravel Unit E.

3F-25

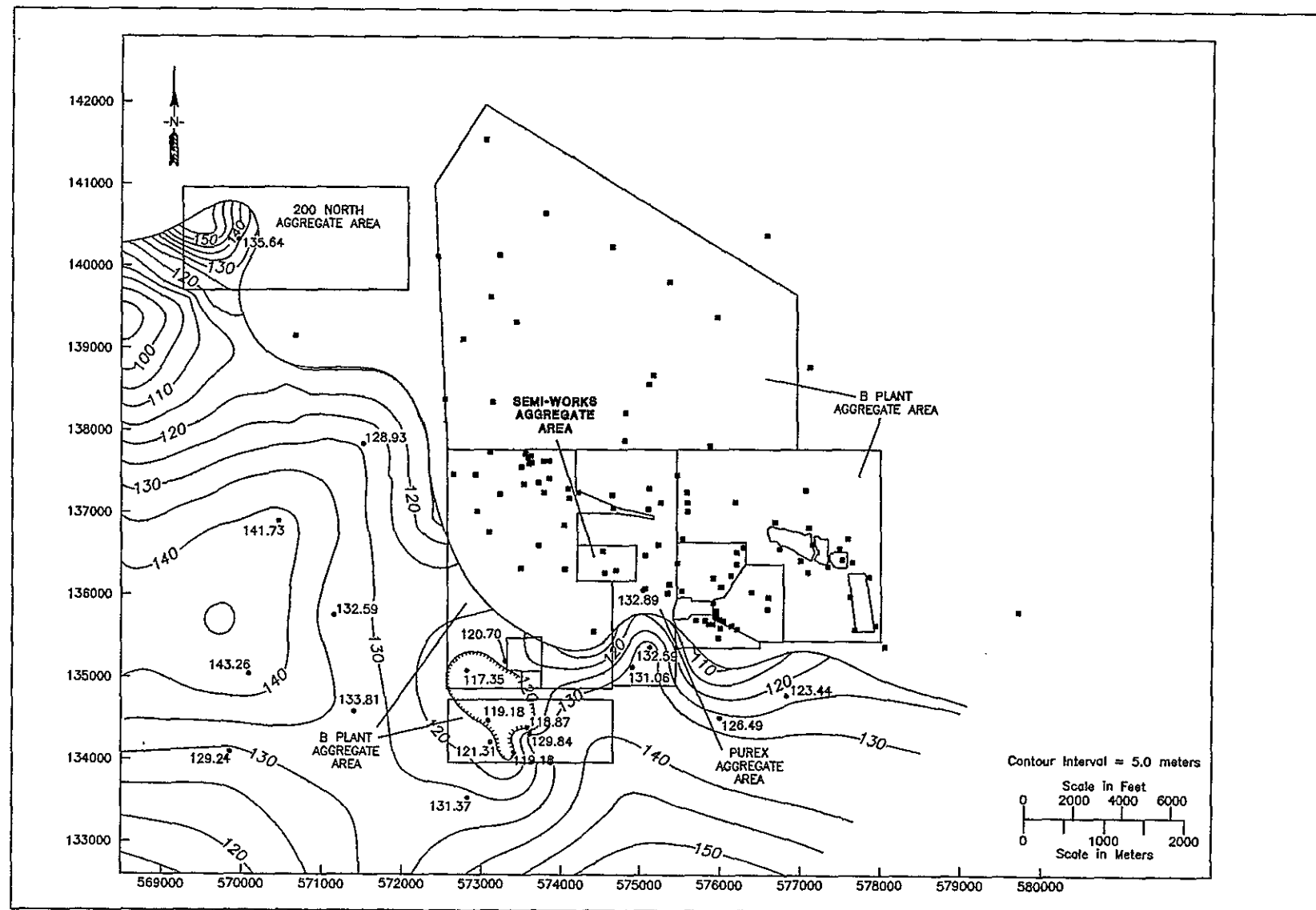


Figure 3-25. Structure Contour Map of the Ringold Gravel Unit E.

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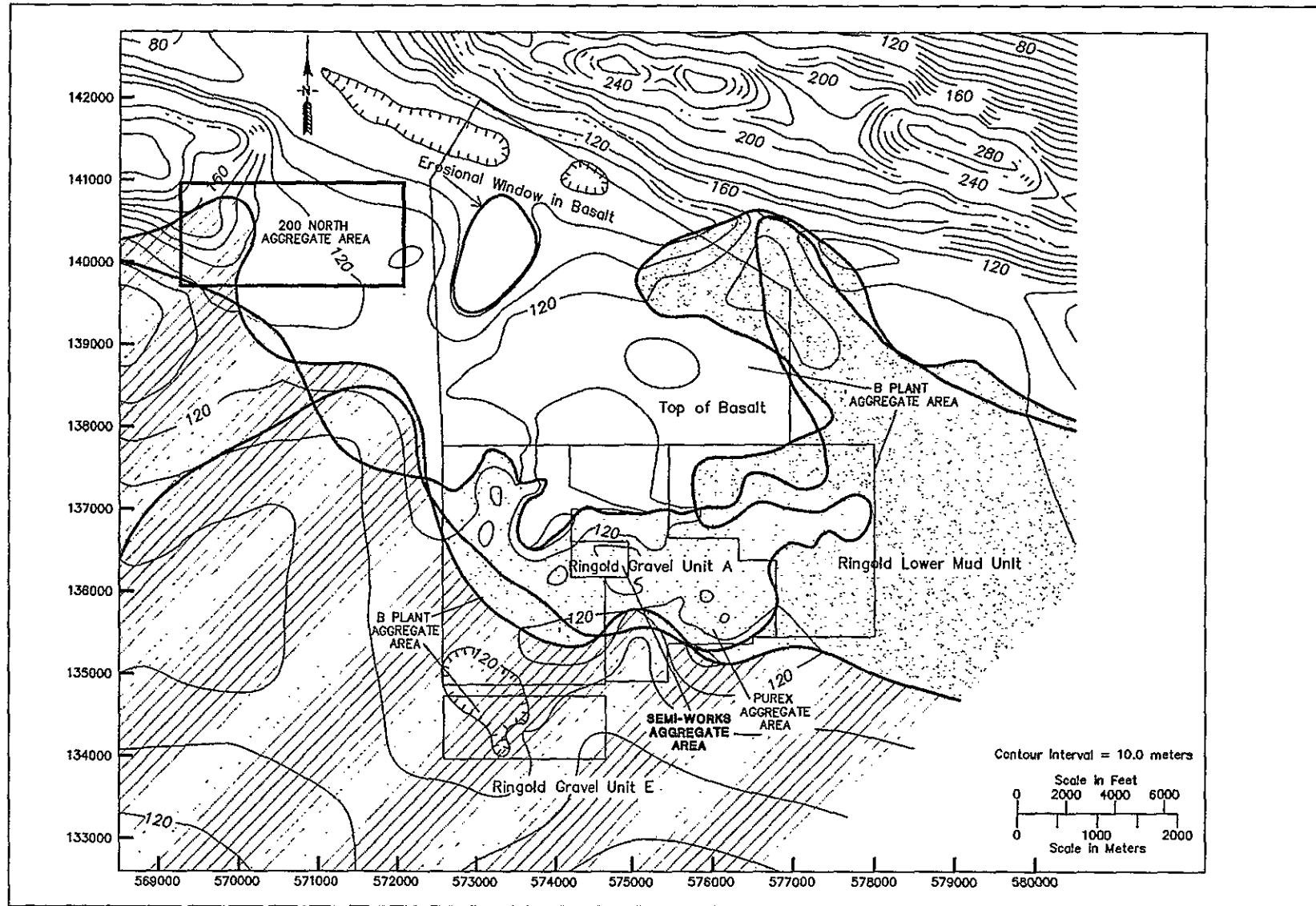


Figure 3-26. Structure Contour Map of the Top of the Ringold Formation.

3F-27

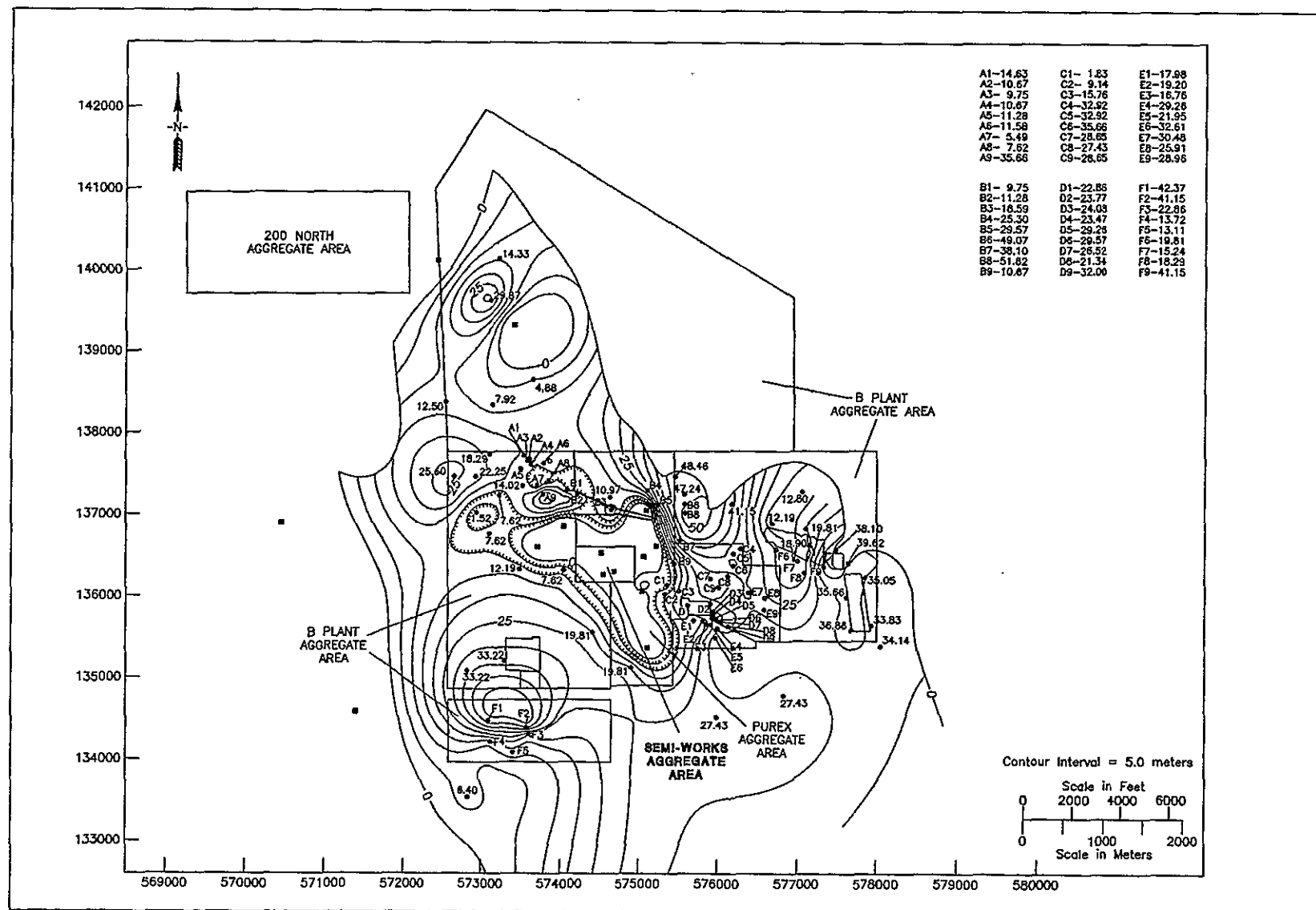
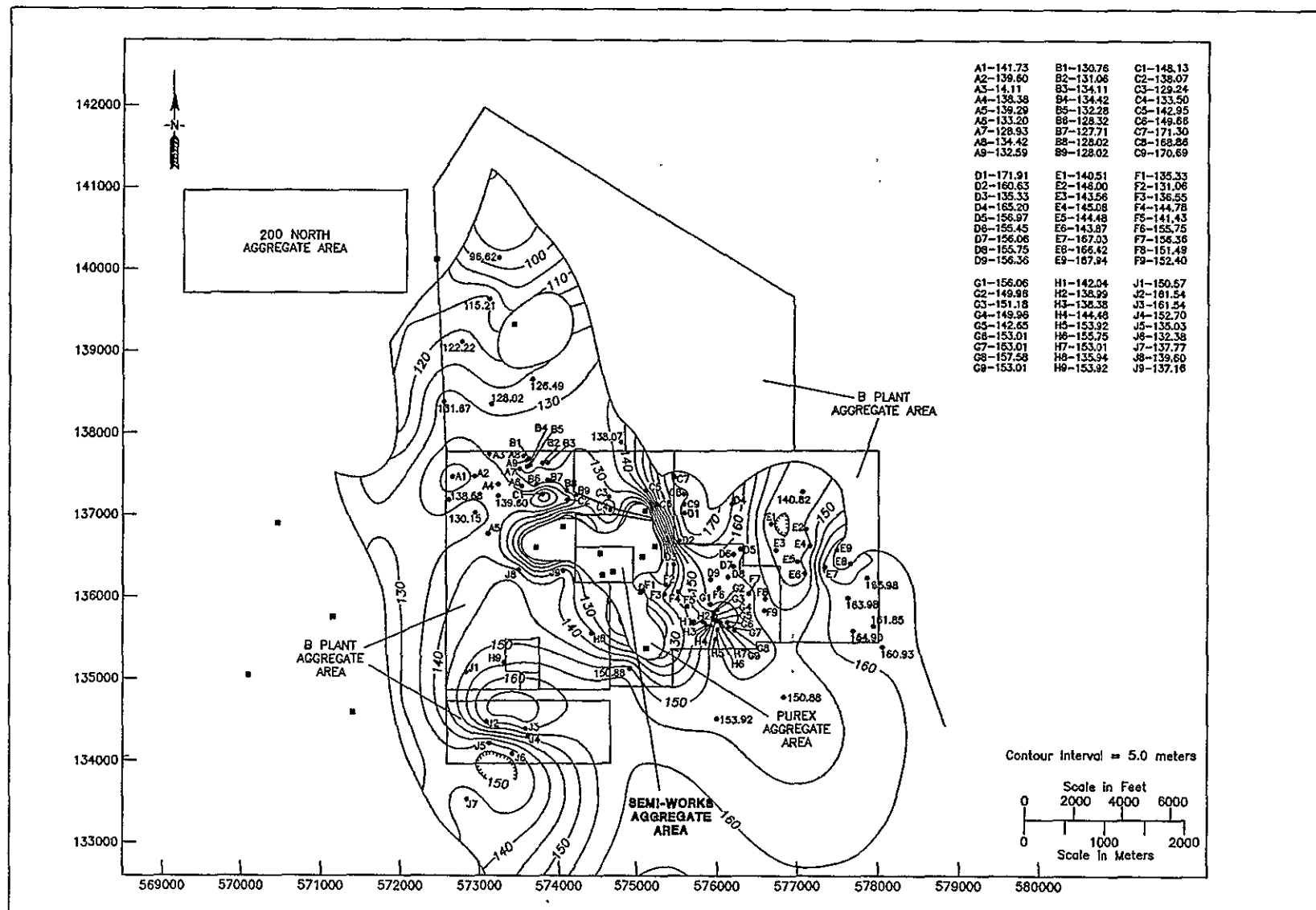
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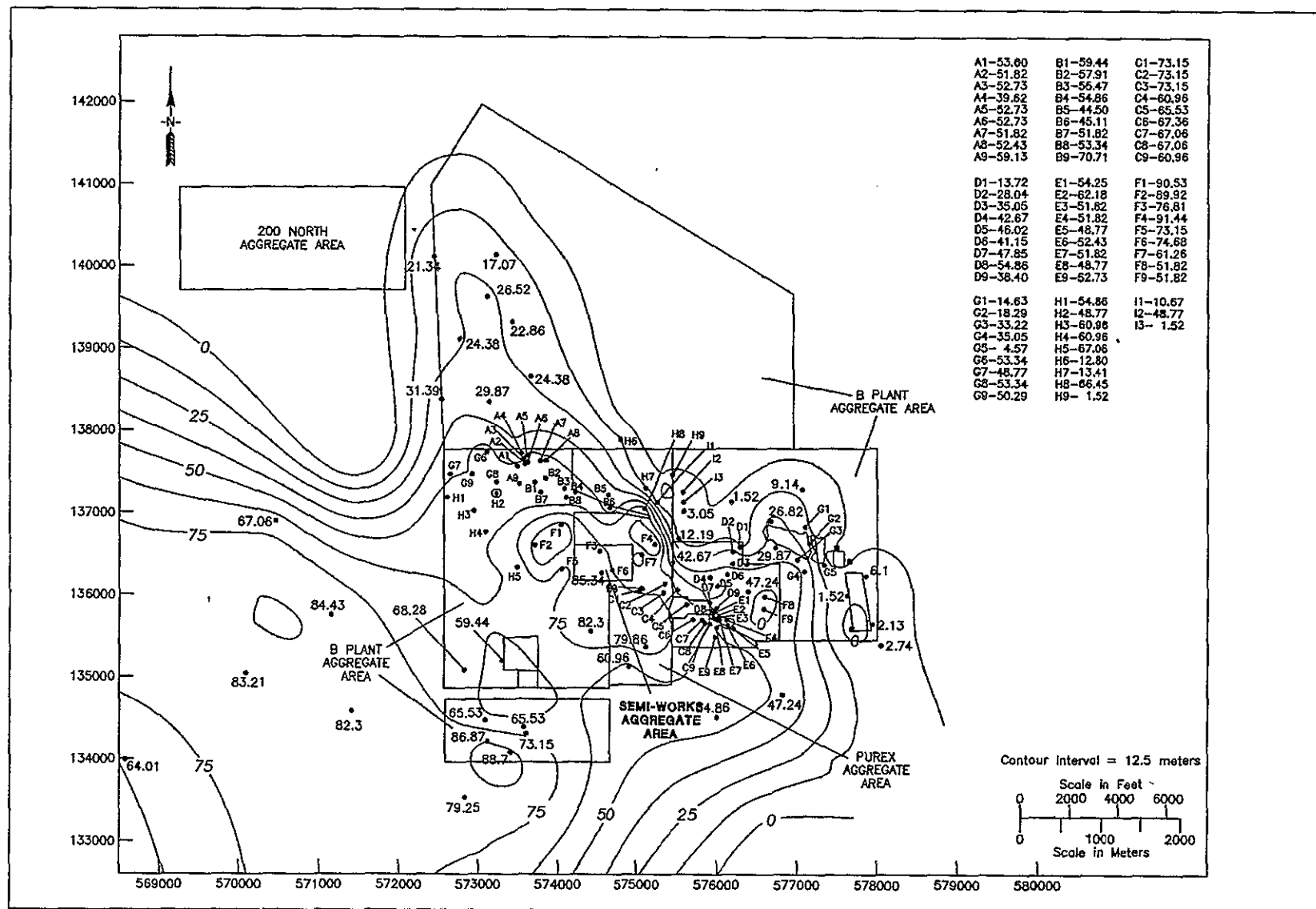
Figure 3-27. Isopach Map of the Lower Gravel Sequence, Hanford Formation.

3F-28



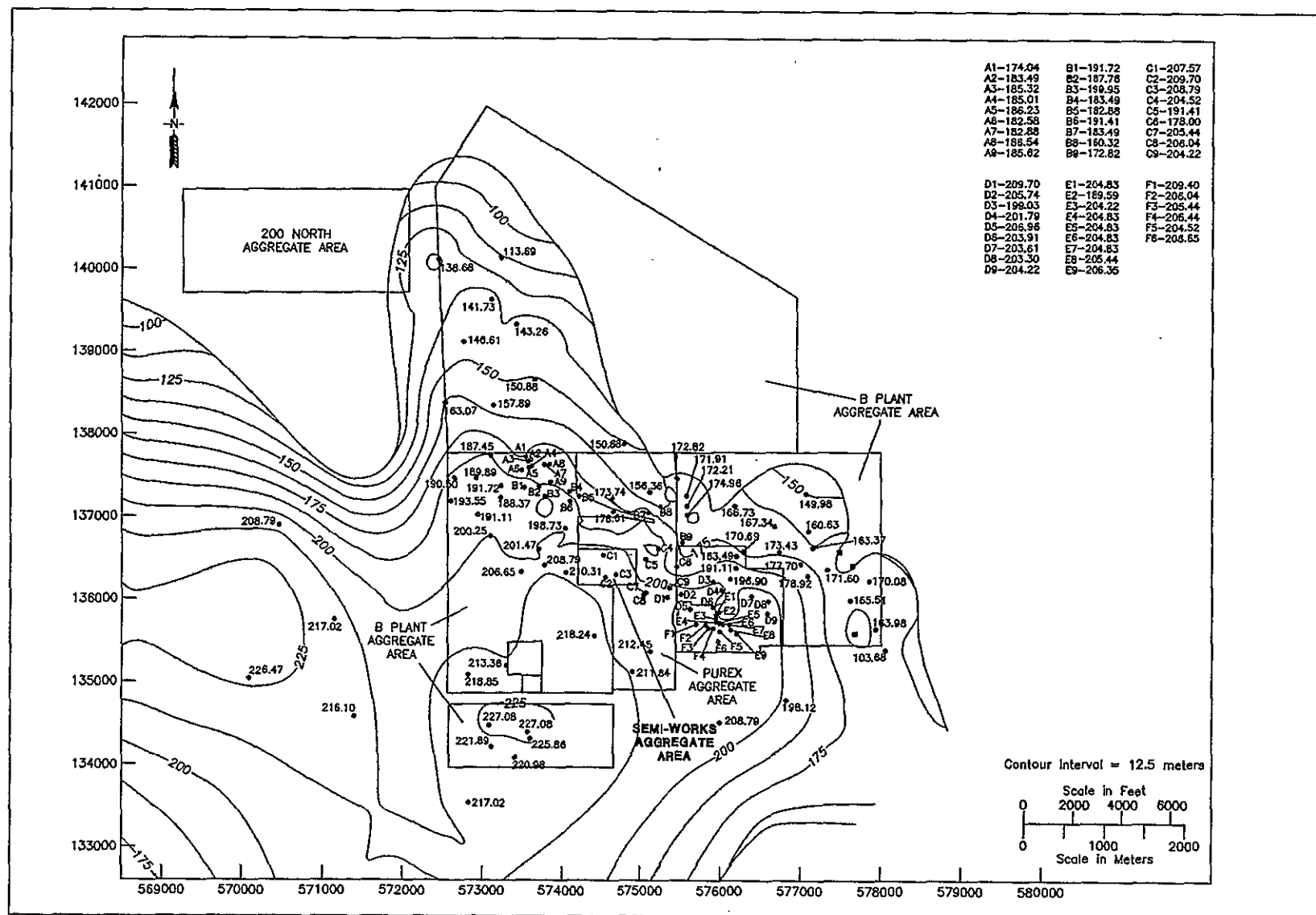
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Figure 3-28. Structure Contour Map of the Top of the Lower Gravel Sequence, Hanford Formation.



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Draft A

Figure 3-29. Isopach Map of the Sandy Sequence, Hanford Formation.



DOE/RL-92-18
Draft A

Figure 3-30. Structure Contour Map of the Top of the Sandy Sequence, Hanford Formation.

3F-31

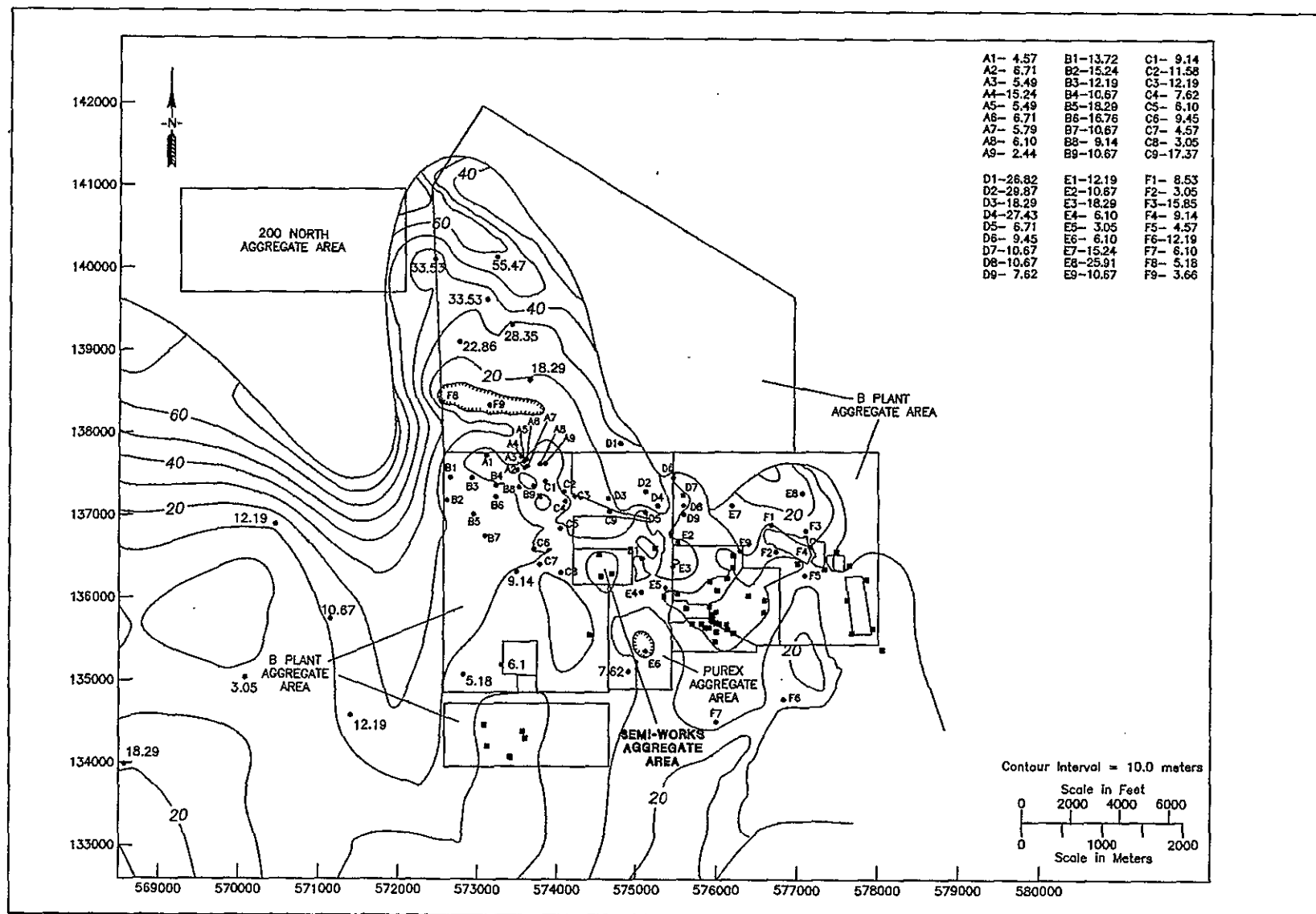
DOE/RL-92-18
Draft A

Figure 3-31. Isopach Map of the Upper Coarse Gravel Sequence, Hanford Formation.

3F-32

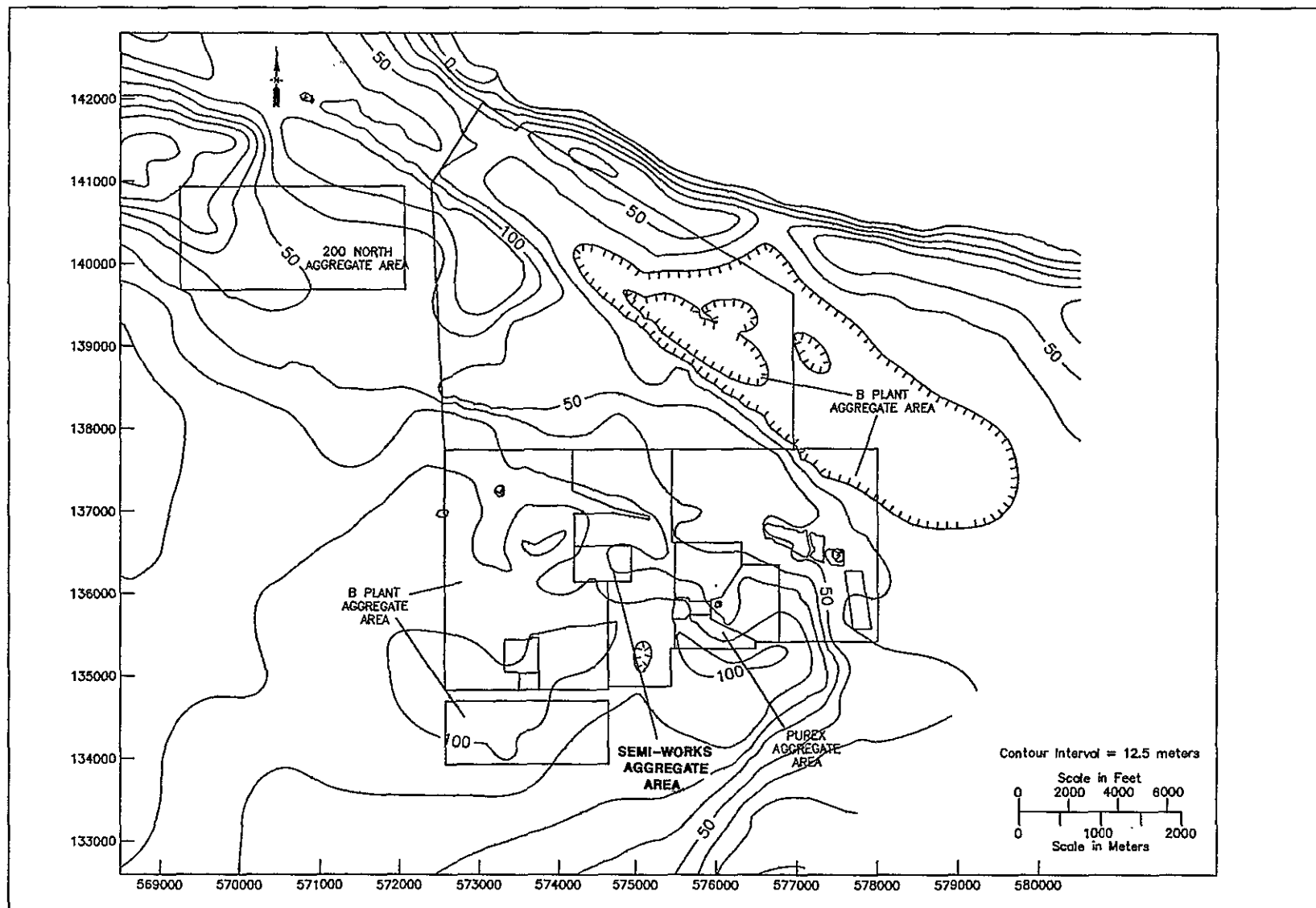
DOE/RL-92-18
Draft A

Figure 3-32. Isopach Map of the Entire Hanford Formation.

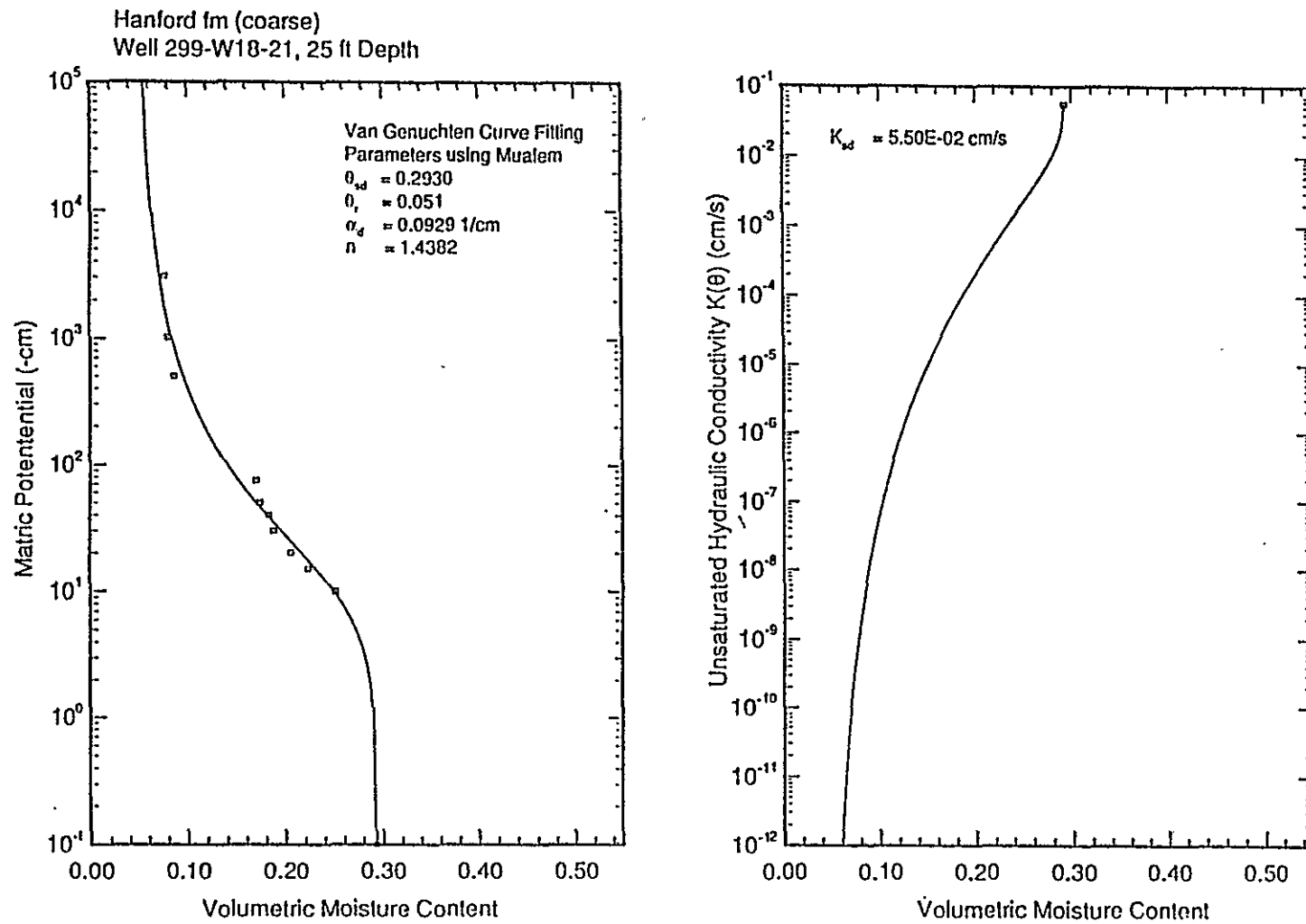
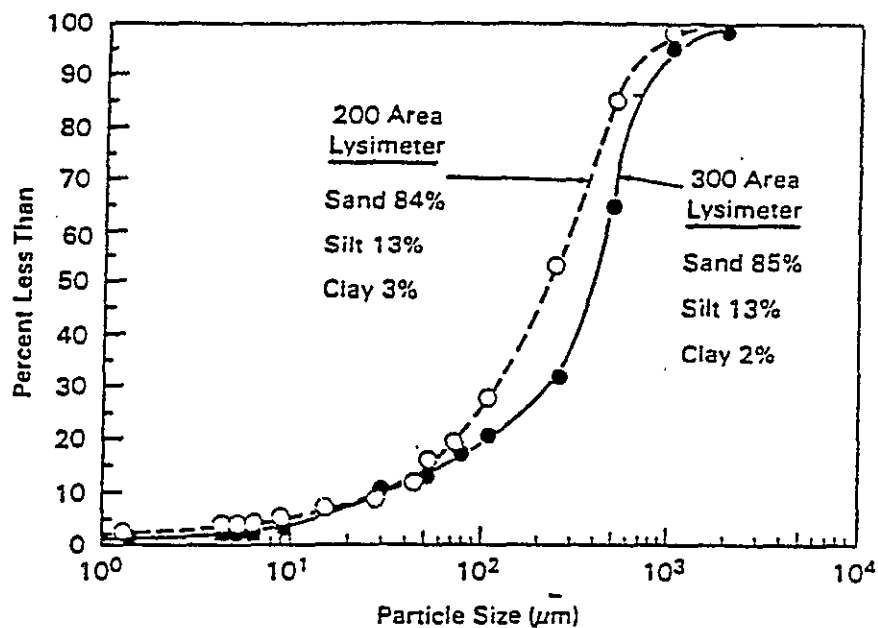
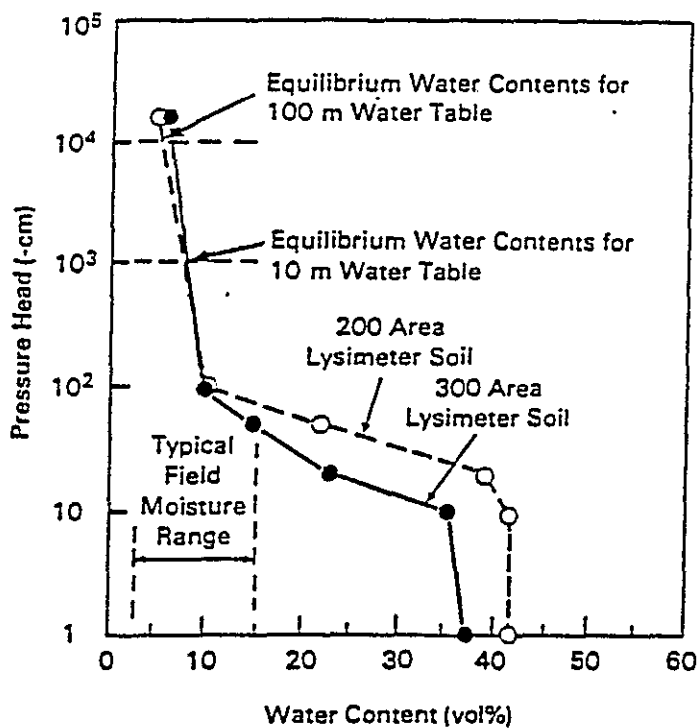


Figure 3-33. Wetting and Drying Curves for Well 299-W18-21.

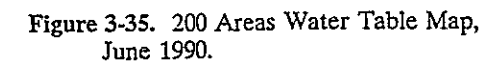


a. Particle-Size Distribution



b. Water Retention Characteristics

Figure 3-34. Particle Size Distribution and Water Retention Characteristics of Soils from Hanford Site Lysimeters.



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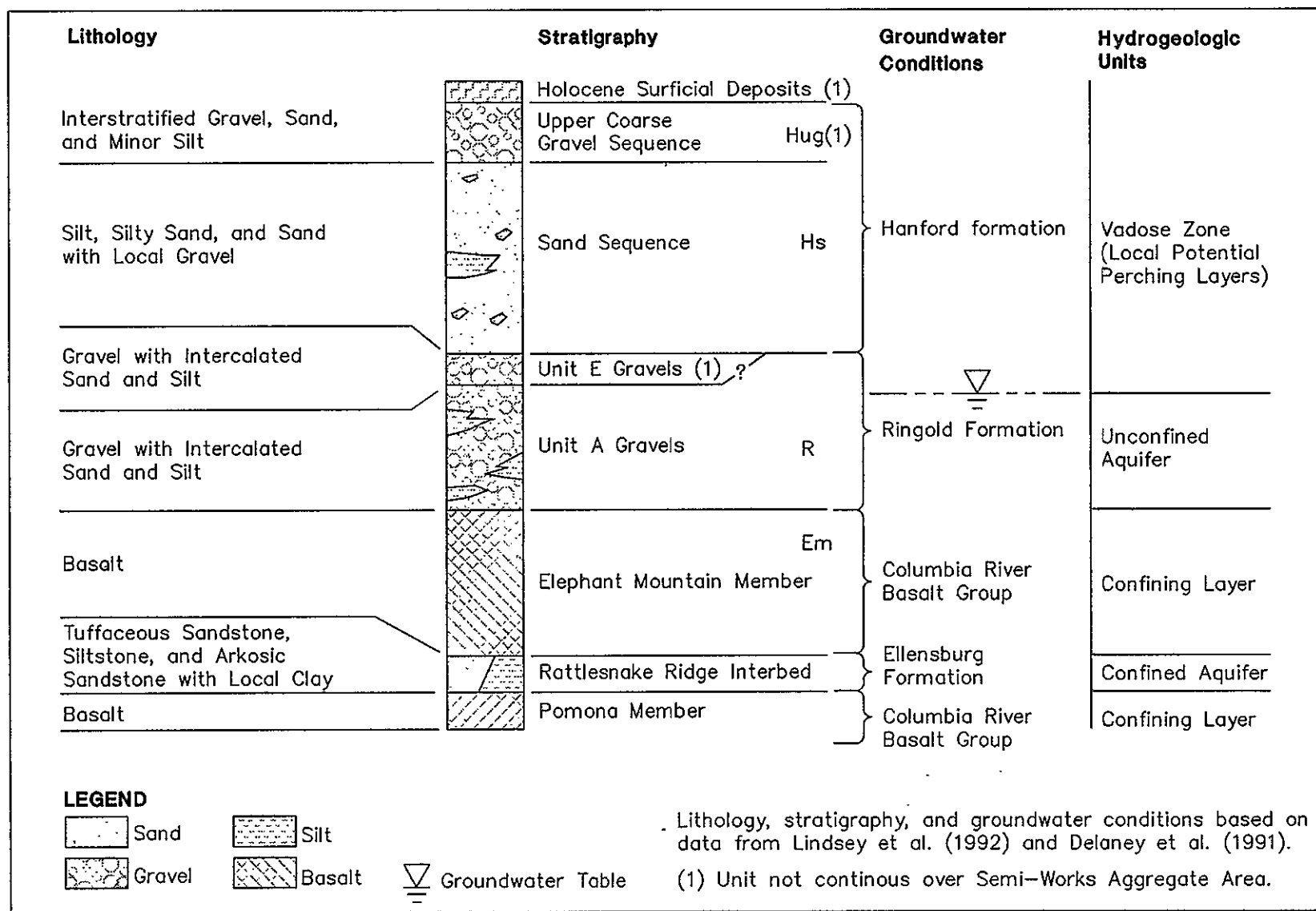


Figure 3-36. Conceptual Hydrogeologic Column for the Semi-Works Aggregate Area.
(Lindsey et al. 1992; Delaney et al. 1991)

Table 3-1. Hydraulic Parameters for Various Areas and Geologic Units at the Hanford Site.

Location	Interval tested	Hydraulic Conductivity	
		in m/d	in ft/d
Pasco Basin	Hanford formation	150 to 6,200	500 to 20,300
	Ringold Formation Unit E	6 to 180	20 to 600
	Ringold Formation Unit A	0.03 to 3	0.1 to 10
100 Area	Ringold Formation Unit E	9 to 395	29 to 1,297
200 Areas	Hanford formation	610 to 3,050	2,000 to 10,000
	Ringold Formation Unit E	2.7 to 70	9 to 230
	Ringold Formation Unit A	0.3 to 3.6	1 to 12
200 West Area	Ringold Formation Unit E	0.02 to 61	0.06 to 200
	Ringold Formation Unit A	0.05 to 1.2	1.7 to 4
	Lower Ringold laboratory	9×10^{-6} to 2.4×10^{-5}	3×10^{-5} to 8×10^{-5}
Slug Tests at U-12 Crib	Upper Ringold	2.4 to 13	8 to 44
300 Area	Hanford formation	3,350 to 15,250	11,000 to 50,000
300 Area	Ringold Formation	0.58 to 3,050	1.9 to 10,000
1100 Area	Ringold Formation Units C/B	0.09 to 1.5	0.3 to 5
1100 Area	Ringold Formation Overbank Deposits	2.4×10^{-4} to 0.03	8×10^{-4} to 0.1

Source: Delaney et al. 1991

Table 3-2. Summary of Reported Hydraulic Conductivity Values for Hanford Site Vadose Zone Sediments. (Sheet 1 of 2)

Reported Hydraulic Conductivity Value or Range of Values in cm/s	Water Content Volume Percent	Reported Geologic Unit or Sediment Type	Test Area or Sampling Location	Measurement Method or Basis for Reported Value
6.7 x 10 ⁻⁷	10	Sand	200 Area	Lysimeter Soil Experiments
1.7 x 10 ⁻⁸	7			
1.7 x 10 ⁻⁹	5.5			
1.7 x 10 ⁻¹⁰	5			
1.3 x 10 ⁻¹¹	4.3			
2.6 x 10 ⁻³	31	Sandy soil reported as "typical or many surface materials at the Hanford Site."		Unsaturated column studies.
5.7 x 10 ⁻⁴ (sat)	56			
6.3 x 10 ⁻¹¹	2.9	Near-surface soils	2-km south of 200 East Area	K estimates using water retention curve data.
2.2 x 10 ⁻¹¹	2.8			
5.40 x 10 ⁻⁸	8.3	Sandy fill excavated from near-surface soil (Hanford formation) with 1.27-cm particle size fraction screened out.	Buried Waste Test Facility (BWTF): 300 North Area Burial Grounds	Laboratory steady-state flux measurements.
9.78 x 10 ⁻³ (sat)	42.2			
8.4 x 10 ⁻³ (sat, arithmetic mean of four measurements)	na			
8 x 10 ⁻⁸	11	na	BWTF: Southeast Caisson, and North Caisson	Unsteady drainage-flux field measurements.
4 x 10 ⁻³ (Southeast Caisson)	26	na		
1 x 10 ⁻⁸	10	na		
1 x 10 ⁻² (North Caisson)	29	na		
4.5 x 10 ⁻³ (arithmetic mean of 15 measurements)	Field Saturation	na	BWTF North Caisson and area north of caisson	Guelph permeameter field measurements

Table 3-2. Summary of Reported Hydraulic Conductivity Values for Hanford Site Vadose Zone Sediments. (Sheet 2 of 2)

Reported Hydraulic Conductivity Value or Range of Values in cm/s	Water Content Volume Percent	Reported Geologic Unit or Sediment Type	Test Area or Sampling Location	Measurement Method or Basis for Reported Value
1×10^{-3} (Upper Soil, arithmetic mean of 7 measurements)	Field Saturation	Loam sand over sand	Grass Site; 3 km of BWTF	Guelph permeameter field measurements
9.2×10^{-3} (Lower Soil, arithmetic mean of 4 measurements)	Field Saturation	na		
8×10^{-7}	16	Loam to sandy loam	McGee Ranch: NW of 200 West Area on State Rt. 240	Unsteady drainage-flux field measurements.
9×10^{-4}	40			
9×10^{-4} (arithmetic mean of 9 measurements)	Field Saturation	na		Guelph permeameter field measurements.
5×10^{-3} (sat)	50	Sand, Gravel	Sediment types are idealized to represent stratigraphic layers commonly encountered below 200 Areas liquid disposal sites.	K_{sat} values derived from idealized moisture content curves.
1×10^{-3} (sat)	50	Coarse Sand		
5×10^{-4} (sat)	40	Fine Sand		
1×10^{-4} (sat)	40	Sand, Silt		
5×10^{-5} (sat)	40	Caliche		
1.2×10^{-5} (sat)	19.6 to 18.9	Hanford formation	Well 299-W7-9, 218-W-5 Burial Ground	van Genuchten equation fitted to moisture characteristic curves for Well 299-W7-9 soil samples
6.7×10^{-6} to 2.8×10^{-1} (sat)	37.6 to 41.4	Early "Palouse" Soils		
1.10×10^{-3} (sat)	18.3 to 21	Upper Ringold		
1.80×10^{-4} to 3.00×10^{-4} (sat)	24 to 25	Middle Ringold		

Notes:

na - Not identified in source.

sat - Value for saturated soil.

field saturation - Equilibrium water content after several days of gravity drainage.

Table 3-3. Endangered, Threatened, and Sensitive Plant Species reported on or near the Hanford Site.

Scientific Name	Common Name	Family	Washington State Status
<i>Rorippa columbiae</i> ** Suksd. ex Howell	Persistent-sepal Yellowcress	Brassicaceae	Endangered
<i>Artemisia campestris</i> L ssp. <i>borealis</i> (Pall.) Hall & Clem. var. <i>wormskioldii</i> ** (Bess.) Cronq.	Northern Wormwood	Asteraceae	Endangered
<i>Astragalus columbianus</i> ** Barneby	Columbia milk-vetch	Fabaceae	Threatened
<i>Lomatium tuberosum</i> ** Hoover	Hoover's Desert-Parsley	Apiaceae	Threatened
<i>Astragalus arrectus</i> Gray	Palouse Milk-vetch	Fabaceae	Sensitive
<i>Collinsia sparsiflora</i> Fisch.&Mey. var. <i>bruciae</i> (Jones) Newsom	Few-Flowered Collinsia	Scrophulariaceae	Sensitive
<i>Cryptantha interrupta</i> (Greene) Pays.	Bristly Cryptantha	Boraginaceae	Sensitive
<i>Cryptantha leucophea</i> Dougl. Pays	Gray Cryptantha	Boraginaceae	Sensitive
<i>Erigeron piperianus</i> Cronq.	Piper's Daisy	Asteraceae	Sensitive
<i>Carex densa</i> L.H. Bailey	Dense Sedge	Cyperaceae	Sensitive
<i>Cyperus rivularis</i> Kunth	Shining Flatsedge	Cyperaceae	Sensitive
<i>Limosella acaulis</i> Ses.&Moc.	Southern Mudwort	Scrophulariaceae	Sensitive
<i>Lindernia anagallidea</i> (Michx.) Pennell	False-pimpernel	Scrophulariaceae	Sensitive
<i>Nicotiana attenuata</i> Torr.	Coyote Tobacco	Solanaceae	Sensitive
<i>Oenothera pygmaea</i> Dougl.	Dwarf Evening-Primrose	Onagraceae	Sensitive

** Indicates candidates on the 1991 Federal Register, Notice of Review.

Table 3-4. Federal and State Classifications of Animals That Could Occur on the 200 Areas Plateau.

Common Name	Status Federal*	State
Peregrine Falcon	FE	SE
Sandhill Crane		SE
Bald Eagle	FT	ST
Ferruginous Hawk	FC2	ST
Swainson's Hawk	FC2	SC
Golden Eagle		SC
Burrowing Owl		SC
Loggerhead Shrike		SC
Sage Sparrow		SC
Great Blue Heron		SM
Merlin		SM
Prairie Falcon		SM
Long-billed Curlew		SM
Striped Whipsnake		SC

*FE - Federal Endangered

FT - Federal Threatened

FC2 - Federal Candidate

SE - State Endangered

ST - State Threatened

SC - State Candidate

SM - State Monitor

Source: WHC 1992b.

4.0 PRELIMINARY CONCEPTUAL SITE MODEL

Section 4.1 presents the chemical and radiological data that are available for each waste management unit and unplanned release. These data, along with physical descriptions of the waste management units and unplanned releases (Section 2.0) and descriptions of the surrounding environment (Section 3.0) are evaluated in Section 4.2 and Section 5.0 in order to qualitatively assess the potential impacts of the contamination to human health and to the environment. The quality and sufficiency of the existing data are assessed in Section 8.0. This information is also used to identify potential ARARs (Section 6.0). Contaminant information is assessed in Section 7.0 to provide a basis for selecting technologies which can be implemented at the waste management units and unplanned release sites.

Contaminants that are released into the environment at a waste management unit or unplanned release site may migrate from the point of release into other types of media. Types of data for the Semi-Works Aggregate Area waste management units are listed in Table 4-1. The potentially affected media in the Semi-Works Aggregate Area include surface soil, surface water, vadose zone soil and perched groundwater, air, and biota. The media that are affected at a specific site will depend upon the quantities, chemical and physical properties of the material released, and the subsequent site history. The potentially affected media at each waste management unit or unplanned release site are listed in Table 4-2 for radionuclide contamination and Table 4-3 for chemical contamination.

4.1 KNOWN AND SUSPECTED CONTAMINATION

There are two major categories of chemical and radiological data available for the Semi-Works Aggregate Area: site-specific data that are applicable to individual waste management units and unplanned releases; and area-wide environmental data that are useful in characterizing regional contamination trends.

Some waste management units and unplanned releases have been the subject of chemical and radiological studies in the past; however, most of these studies were limited in scope and did not provide a comprehensive analysis of the character and distribution of the contamination at each site. The types of site-specific data that are available for some sites include inventory information, surface radiological contamination surveys, external radiation dose rate monitoring, soil sampling, biota sampling, borehole geophysics, and analysis of waste streams and tank contents.

1 Table 4-1 summarizes the types of site-specific data available for each of the waste
2 management units and unplanned releases. It should be emphasized that the table only
3 summarizes what types of data are available; it does not indicate the sufficiency of the
4 data, either in terms of quality or quantity. These concerns are addressed in Section 8.0.
5 The site-specific information is presented for each waste management unit and
6 unplanned release in Section 4.1.2 of this report.

7
8 In addition to these site-specific data, there are area-wide data that are not
9 directly applicable to any waste management unit or unplanned release within the
10 Semi-Works Aggregate Area. The most important sources of this general environmental
11 data are quarterly and annual environmental surveillance reports published by
12 Westinghouse Hanford. There are also area-wide geophysical data available that include
13 gravity, magnetic, magnetotelluric, seismic refraction, and seismic reflection surveys (DOE
14 1988a). However, these studies are not useful for characterizing the extent of chemical
15 and radionuclide contamination and are not presented in Section 4.0. These data are
16 discussed in more detail in Section 8.1.2.

17
18 Groundwater issues are considered beyond the scope of this study. The
19 interrelation between sources and groundwater plumes will be addressed in the 200 East
20 Groundwater AAMS.

21
22 The most recent environmental monitoring of the Hanford Site was conducted by
23 the PNL and Westinghouse Hanford. However, most of the data that are applicable to
24 the Semi-Works Aggregate Area have been published by Westinghouse Hanford. The
25 last six annually published environmental surveillance reports (Elder et al. 1986, 1987,
26 1988, and 1989; Schmidt et al. 1990 and 1992) were reviewed for this study. The annual
27 reports describe several different sampling and survey programs including surface soil
28 sampling, external radiation measurements, biota sampling, air sampling, surface water
29 sampling, groundwater sampling, and radiological surveys.

30
31 Soil, surface water, and biota samples were collected each year at the same
32 locations within the 200 East Area. Air and external radiation measurements were also
33 taken annually at several locations. Until 1990 few of the sample locations were directly
34 associated with any of the identified waste management units and unplanned releases and
35 most of this information is only useful in characterizing area-wide trends. In 1990,
36 however, new sampling locations were established that are near areas of known surface
37 contamination. Only one of the new soil sampling locations is within the Semi-Works
38 Aggregate Area (Schmidt et al. 1992).

39
40 The latest Westinghouse Hanford Quarterly Environmental Radiological Survey
41 Summary Reports were reviewed during the current study. In addition, radiation survey
42 reports were obtained from the Operational Health Physics division of Westinghouse

1 Hanford which provide detailed accounts of dose rates and contamination levels
2 measured at specific locations within the Semi-Works Aggregate Area.

3
4 Section 4.1 describes available data regarding known and suspected contamination
5 in the Semi-Works Aggregate Area on a media-specific basis (air, surface soil, surface
6 water, biota, vadose zone soil, and waste materials). The text summarizes sources of
7 chemical and radiological sampling information. Section 4.1.1 presents data on a
8 media-specific basis. Section 4.1.1.1 presents results of air quality sampling data. Surface
9 soil data are described in Section 4.1.1.2. Surface water sampling is discussed in Section
10 4.1.1.3. Results of vegetation and other biota sample analyses are presented in Section
11 4.1.1.4. Available vadose zone sampling data are presented in Section 4.1.1.5. Section
12 4.1.1.5 also discusses evidence of contamination migration within the vadose zone to the
13 unconfined aquifer underlying the site. Additional assessment of the nature and extent of
14 groundwater contamination will be presented in the 200 East Groundwater AAMS.

15
16 To supplement available radiological and chemical analytical data, historical waste
17 inventory information for the Semi-Works Aggregate Area waste management units and
18 unplanned releases was also included in the evaluation of known and suspected
19 contaminants. Historical waste inventory data are detailed in Section 2.0 of this report
20 (Tables 2-2 and 2-3). As discussed in Section 2.0, the compilation is based on supporting
21 data from WIDS (WHC 1992a).

22 23 24 **4.1.1 Affected Media**

25
26 **4.1.1.1 Air.** Four high volume air samplers are stationed within or adjacent to the
27 Semi-Works Aggregate Area as shown on Figure 4-1 and Plate 2. The samplers contain
28 filters that collect airborne particulates.

29
30 The air samples are collected by drawing air at a flow rate of 0.06 m³/min
31 (2 ft³/min) through a 47 mm (0.014 ft) open face filter positioned about 1 m (3.3 ft)
32 above the ground. Throughout the 200 Areas, air samplers are operated on a continuous
33 basis. Sample filters are exchanged weekly, held one week to allow for decay of
34 short-lived natural radioactivity, and sent for initial laboratory analyses of gross alpha and
35 beta activity. After the initial analysis, the filters are stored until the end of the calendar
36 quarter, at which time they are composited by sample location (or as deemed
37 appropriate according to data need) and sent for laboratory analyses of specific
38 radionuclides. Compositing of the filters by sample location provides a larger sample
39 size, and thus, a more sensitive measurement of the concentration of airborne
40 radionuclides resulting from operations in the 200 Areas.

1 The filters are analyzed quarterly for ^{90}Sr , ^{137}Cs , ^{239}Pu , and total U. The results
2 appear to indicate a general decline in the concentration of these radionuclides from
3 1985 to 1989 throughout the 200 East Area (Schmidt et al. 1990). The last five years of
4 data for the Semi-Works Aggregate Area are summarized as an annual average for each
5 sampling location in Table 4-4. Air samples were measured only during 1988 and 1989;
6 in 1989 only one sampling location was reported. The complete data set since 1985 is
7 summarized in Table A-1 in Appendix A.

8
9 **4.1.1.2 Surface Soil.** Sources of data available for characterizing surface soil
10 contamination include aerial radiological surveys, external radiation measurements and
11 surface soil sampling and analysis. These data will be presented in the following sections.
12 In addition, a limited amount of site-specific radiological data is available; these data will
13 be presented in the appropriate sections of Section 4.1.2.

14
15 **4.1.1.2.1 Radiological Surveys.** Radiological contamination survey results may be
16 influenced by buried or airborne radionuclide contamination but are generally indicative
17 of surface and shallow soil contamination. An aerial gamma-ray radiation survey was
18 performed over the 200 East Area in July and August of 1988. The survey lines were
19 flown with a 122 m (400 ft) spacing at an altitude of 61 m (200 ft). The data were
20 normalized to a height of 1 m (3.3 ft) above the ground surface. Figure 4-2 presents the
21 gross count data (ct/s) on an isoradiation contour map that covers the entire 200 East
22 Area.

23
24 The entire Semi-Works Aggregate Area has gross gamma counts that are above
25 background. The highest gross count results in the Semi-Works Aggregate Area were
26 between 70,000 and 200,000 ct/s. The highest count area is not clearly related to any
27 present or past feature of the Semi-Works Aggregate Area, but rather appears to be
28 related to unplanned releases and contaminated equipment along the TC-4 railroad spur
29 in the PUREX Aggregate Area. However, a bulge in the 7,000 to 22,000 ct/sec
30 isoradiation contour centered above the Semi-Works production area appears to indicate
31 that releases from waste management units are contributing to the overall gamma
32 readings in this area. It is nearly impossible to convert these gross gamma counts to a
33 meaningful exposure rate because of the complex distribution of radionuclides on the
34 site. As such, the aerial radiation survey data should only be used as a qualitative tool
35 for identifying more highly contaminated areas within the survey boundaries. In addition,
36 the gamma counts noted in the survey probably result from both surface and shallow
37 buried radionuclides. Thus, they are not entirely indicative of surface contamination.

38
39 Elevated radiation zones identified by the aerial survey generally correspond to
40 areas where surface contamination has been noted by surface radiation surveys. Figure
41 4-3 shows the current status of areas posted due to surface contamination, underground
42 contamination, and migration of surface contamination identified from surface surveys.

Table 4-5 summarizes the current radiological survey results for each waste management unit and unplanned release. Radiation measurements are reported as one or more of the following measures: radiological activity (in disintegrations per minute [dis/m] or counts per minute [ct/min]), biological dose (in mrem/hr) or smearable alpha activity, which is operationally defined as the level of alpha radioactivity that can be removed from a standard size area of a solid surface (e.g., a wall) by wiping with an absorbent swab. The areas of contamination will be discussed in more detail in the section dealing with the individual waste management units and unplanned releases (Section 4.1.2). Surface radiological surveys are done quarterly, semiannually, or annually at the waste management units. The surface contamination posting may change often because of resurveying and because of cleanups effected under the Radiation Area Remedial Action (RARA) Program.

4.1.1.2.2 External Radiation Dose Rate Measurements. Dose rates from penetrating radiation were measured annually at a series of grid points that covers the 200 East Area with 36 sampling points. The sample point locations have never been exactly surveyed, but are located close to the intersections of Hanford Site coordinate lines at 610 m (1,000 ft) spacings. Two of the grid points are located within or adjacent to the Semi-Works Aggregate Area (see Figure 4-1). Location 2E22, which is sited just south of the Semi-Works Aggregate Area boundary, was included because it is likely to be impacted by surface contamination released from Semi-Works unplanned releases. Two additional grid locations just beyond the northeast and southeast corners of the Semi-Works Aggregate Area were not included in this discussion, because these samples are in close proximity to the 241-C Tank Farm and PUREX facility, respectively, and are not likely to be representative of conditions within the Semi-Works Aggregate Area. The results of measurements made from 1985 to 1988 are presented in Table 4-6. Sample locations were changed in 1989; none of the new locations are within the Semi-Works Aggregate Area. The measurements were taken with thermoluminescent dosimeters (TLDs) and are reported in mrem/yr. The TLDs measure dose rates resulting from all types of external penetrating radiation sources including cosmic radiation, naturally occurring radioactivity, fallout from nuclear weapons testing, and contributions from other Hanford Site activities. The TLD measurements have ranged from 64 to 114 mrem/yr. The average reading for the two sites in 1988 was 102 mrem/yr.

4.1.1.2.3 Surface Soil Sampling. Between 1978 and 1989 surface soil samples were collected annually from the same two grid locations discussed for the external dose rate measurements. In addition, between 1984 and 1989, soils were sampled along fences enclosing the 200 East Area. None of the fenceline soil sampling locations are within or close to the Semi-Works Aggregate Area.

The results of the grid soil sampling program from 1985 through 1989 are summarized in Table 4-7. A complete list of the data collected during this period is

presented in Table A-2 in Appendix A. Counting errors are included with each analytical result and those values that are higher than the accompanying counting errors are denoted with shading.

The most commonly detected radionuclides were ^{90}Sr , ^{137}Cs , U total, ^{238}Pu , ^{239}Pu , and ^{152}Eu . These species were found consistently at concentrations above counting errors.

Grid point 2E22 was not sampled in 1987 or 1989. Neither grid point was sampled in 1989. In 1990, one surface soil sample was collected at a location north of the Semi-Works Complex, north of 7th Street. Analytical results for this sample are shown in Table 4-8.

4.1.1.3 Surface Water. Surface water currently is present in the Semi-Works Aggregate Area only in the 200 East Powerhouse Ditch. The 216-C-9 Pond no longer contains water and has been backfilled and converted to a solid waste burial ground. No surface water sampling data was available in the documents reviewed for these waste units.

The source of water entering the 200 East Powerhouse Ditch is the 284-E Power Plant located south of the Semi-Works Aggregate Area. Water entering the Powerhouse Ditch was characterized in the *284-E Power Plant Wastewater Stream-Specific Report* (WHC 1990b). The most concentrated single contributor to the wastewater is a waste brine solution containing about 9 percent by weight of sodium chloride. It also contains several minor constituents that elevate the dissolved solids content to 10 percent by weight. Other sources of discharge to this ditch include boiler blowdown water containing dissolved boiler scale, a scaling agent (ethylenediaminetetraacetic acid [EDTA]) and sodium sulfite, which is used as an oxygen scavenger. A summary of chemical and radiological measurements of the wastewater is presented in Table 4-9.

4.1.1.4 Biota. Westinghouse Hanford and PNL have conducted various biota sampling activities beginning in 1971 through 1990 inside and outside the Hanford Site. The most recent biota sampling is reported in the document "Hanford Site Environmental Report for Calendar Year 1990" (PNL 1991). None of the samples referenced in this document were collected within the Semi-Works Aggregate Area. Analytical results for biota samples were similar to levels reported in earlier years and were far below applicable standards for radiation dose (PNL 1991). No upward trends in radionuclide concentrations were detected for any of the wildlife species examined. However, a significant downward trend was noted for many sample analytes, particularly ^{137}Cs . Levels of ^{137}Cs observed (e.g., in deer muscle tissue) were in the range of concentrations generally attributed to worldwide fallout (PNL 1991). Three factors are believed to have contributed to the decline in concentration of radionuclides: the cessation of atmospheric testing, the 1971 shutdown of the last Hanford reactor that discharged once-through

1 cooling water to the river, and the reduction of environmental radionuclide
2 contamination associated with some Hanford facilities and operations.

3
4 Biota samples have been collected since 1985 from two sites within the
5 Semi-Works Aggregate Area, namely 2E16 and 2E22. Vegetation samples were collected
6 from the same locations as the grid soil samples described in Section 4.1.1.2 (see Figure
7 4-1 and Plate 2). Average analytical results from 1985 through 1989 are summarized in
8 Table 4-10. Grid point 2E22 was not sampled in 1987, and neither grid location was
9 sampled in 1989. In 1990, new sampling locations were established. A vegetation sample
10 was obtained at location 63 but results from this sample were not yet available. The
11 complete data set from these sampling events is presented in Table A-3 in Appendix A.

12
13 Vegetation samples have generally exhibited detectable levels of radionuclides.
14 The most commonly detected radionuclides at grid point 2E16 are ^{137}Cs and ^{134}Cs . Other
15 species detected at this location are ^{60}Co , ^{152}Eu , ^{103}Ru , and ^{106}Ru . In addition to the
16 above radionuclides, ^{154}Eu and ^{95}Zr were also detected at grid point 2E22. There have
17 been no statistically significant differences for the ^{137}Cs in vegetation from 1985 onwards.
18 The Semi-Works Aggregate Area is an area where tumble weeds blow in from other
19 Hanford Site areas and some of the detected contaminants may originate from other
20 areas of surface radioactivity. Although the prevailing winds tend to blow from the
21 northeast, that is, from the direction of B Plant, the facility does not track migration of
22 tumbleweeds; thus, the source of contaminated vegetation generally is uncertain.

23
24 In addition to the routine vegetation sampling, additional biotic samples were
25 collected for radiological evaluation during some years. A sample of mouse feces
26 collected from an open field within the Semi-Works Aggregate Area in 1987 had a
27 reading of 100,000 ct/m and 10 mrem/hr. The radionuclides analyzed for and the
28 analytical results in pCi/gm dry weight were as follows:

29		
30	^{60}Co	Not detected
31	^{90}Sr	Not reported
32	^{137}Cs	760,000
33	^{154}Eu	3,120
34	^{155}Eu	3,880
35	^{239}Pu	Not reported
36		

37 The source of the contaminated material identified in the mouse feces is
38 indeterminant because of the mobility of the animal. The contaminated mouse feces may
39 be due to an animal contacting sources within or near the main Semi-Works Complex;
40 however, the source was not specifically identified in the annual environmental report.

1 **4.1.1.5 Vadose Zone.** The extent of contamination in the vadose zone has been most
2 studied by limited geophysical borehole logging, which has been conducted in the
3 Semi-Works Aggregate Area since the late 1950s. Gross gamma-ray logs have been used
4 since that time to evaluate radionuclide migration in the vadose zone beneath selected
5 waste management units. However, very little gross gamma data have been published.
6 Table 4-11 lists the logs that were located and reviewed during this study. The gamma
7 log interpretation consisted of identifying zones with anomalously high gamma-ray counts
8 that could be indicative of radionuclide contamination. The depth, thickness, and
9 intensity of these zones were then compared with previous logs from these same holes if
10 existing. Any significant changes may be indicative of contaminant migration in the
11 vadose zone. Interpretations were complicated by the fact that logging equipment and
12 procedures have not been consistent. Attempts made to normalize data collected at
13 different times have met with limited success, and quantitative interpretations were not
14 possible. To attempt normalizing the data would necessitate determining the specific
15 instruments shielding, logging rates, logging procedures, and calibration history of the
16 equipment used. No equipment-specific information is available in the documents
17 reviewed to achieve this.

18
19 Three monitoring wells, 299-E24-8, 299-E27-1, 299-E27-5 and a vadose zone
20 boring, 299-E27-133, are located within the Semi-Works Aggregate Area (Figure 4-1).

21
22 Well 299-E24-8, located 20 m (65.6 ft) south of the 216-C-5 Crib, showed an
23 elevated gamma response in the most recent logging in 1968 and 1976 at depths of 0 to
24 3 m (0 to 9.8 ft) below ground surface. This result has been attributed to a waste
25 transfer line between the B Plant and the 244-AR Vault (Fecht et al. 1977).

26
27 Well 299-E27-1, located 50 m (164 ft) north of the 216-C-9 Pond and the 218-C-9
28 Burial Ground, and well 299-E27-5, located 3 m (9.8 ft) north of the 216-C-10 Crib,
29 showed no elevated response. Soil boring 299-E27-133, located 5 m (16.4 ft) east of the
30 216-C-1 Crib, is a shallow vadose zone well that showed an elevated gamma response
31 near the surface which decreased to near background approximately 12 m (39.3 ft) below
32 land surface.

33
34 The gamma log interpretations are discussed in detail and presented on Figure
35 A-1 in Appendix A. The results of the log interpretations are also summarized with the
36 appropriate waste management units in Section 4.1.2.

37
38 No data resulting from sampling and analyses of vadose zone soils for chemical or
39 radiological contaminants were located for the Semi-Works Aggregate Area. However,
40 one sample of sediment taken from within the casing of the 216-C-2 Reverse Well was
41 analyzed for radionuclide content. The methodology used to obtain this sample was not
42 reported. The results of analysis of this sample by two analytical laboratories are

1 presented in Table 4-12. Radionuclides detected in the sample were ^{137}Cs , ^{154}Eu , ^{155}Eu ,
2 ^{241}Am , ^{90}Sr , and ^{239}Pu .

3
4 Limited information about contaminants that could potentially have entered the
5 vadose zone can be obtained from analysis of the waste streams that discharged to the
6 units. Constituents present in the 284-E Power Plant wastewater, which discharges to the
7 200 East Powerhouse Ditch, are shown in Table 4-9.

8
9 The composition of wastewater from the 209-E Critical Mass Laboratory, which
10 was discharged to the 216-C-7 Crib, is shown in Table 4-13. According to the *209-E*
11 *Laboratory Reflector Wastewater Stream-Specific Report* (WHC 1990c), the only
12 constituents that are elevated more than two times above the levels in the supply water
13 are copper, zinc, and manganese.

14
15 Additional information on the potential for contaminants to migrate to
16 groundwater can be inferred from the waste inventories of the waste management units
17 (see Tables 2-1, 2-2, and 2-3). Those units that have received large volumes of liquid are
18 more likely to cause subsurface contaminant migration. The potential for liquid wastes to
19 migrate through the vadose zone to the groundwater can be conservatively estimated by
20 comparing the volume of waste discharged at each waste management unit to the
21 estimated pore volume in the vadose zone soil column below the waste management unit.
22 If the volume of liquid discharged to the ground is larger than the total soil column pore
23 volume, then it is possible that wastewater could reach the groundwater. These
24 calculations are summarized in Table 4-14. They are based on several conservative
25 assumptions: 1) the discharged water does not spread out laterally from the point of
26 discharge (i.e., the volume of affected vadose zone is equal to the depth to groundwater
27 times the plan-view area of the base of the waste management unit); 2) there is no
28 significant change in liquid volume being introduced to the soil column due to
29 evapotranspiration or precipitation; and 3) the average pore volume of the soil column is
30 between 0.1 and 0.3 (the lower and upper pore volume estimates shown in Table 4-14).
31 According to these calculations six waste management units have the potential for
32 migration of liquid discharges to the unconfined aquifer: the 216-C-1, 216-C-3, 216-C-4,
33 216-C-6, and 216-C-10 Cribs and the 216-C-9 Pond.

34 35 36 4.1.2 Site-Specific Data

37
38 This section presents sampling and analysis data regarding possible releases for
39 individual Semi-Works Aggregate Area waste management units and unplanned releases.
40 The information presented was obtained from reference documents reviewed for the
41 current report. For many of the waste management units and unplanned releases the

information is limited, and the lack of more comprehensive information may constitute significant data gaps.

4.1.2.1 Plants, Buildings, and Storage Areas. Buildings at the Semi Works Aggregate Area included the 201-C Process Building and supporting buildings: 276-C Solvent Handling Facility, 2707-C Storage and Change House, 271-C Aqueous Makeup Building, 215-C Gas Preparation Building, 2704-C Office Building and 291-C Ventilation System Building. The other building is the Critical Mass Laboratory Building which was run by the PNL, and is currently occupied by Westinghouse Hanford Tank Farm Waste Management.

Monitoring conducted at the above buildings was limited to surface radiation surveys; no sampling results of environmental media for chemical or radiological contamination were located during our review.

4.1.2.1.1 Plants and Buildings. The only building-specific data located during our review were surface radiation surveys conducted at the 2704-C and 276-C Buildings. The 2704-C Office Building, located due north of the 201-C Process and 271-C Aqueous Makeup Buildings, housed the offices of the Semi-Works Complex. Radiation surveys conducted by Hanford personnel around the 2704-C Office Building in 1989 and 1990 detected up to 6,000 disintegrations per minute (dis/min) of beta radiation. A 1989 survey of all accessible areas inside the building showed nondetectable levels of contamination.

A survey conducted around the 276-C Solvent Handling Building in 1990 detected up to 25,000 dis/min of beta and gamma radiation in two areas east and southeast of the building. The readings were due to contaminated tumbleweeds and were remediated by removing the vegetation. Information was not located to indicate whether the tumbleweed originated on or off of the Semi-Works Aggregate Area.

Three unplanned releases and one newly identified release are associated with plants and buildings at the Semi-Works Aggregate Area:

- Unplanned Release UN-200-36 involved leakage of radioactive material from a pump removed from the 201-C Process Building in 1967.
- Unplanned Release U-200-E-98 involved detection of ⁹⁰Sr around the 291-C Stack in 1980.
- Unplanned Release UN-200-E-141 is associated with the 2718 Storage Building in the Critical Mass Laboratory Area. This release involved a spill of uranyl nitrate onto a concrete floor.

- A release of radioactive waste from the 241-C Waste Line at the point where it enters the 201-C Process Building was reported in 1957. Soil from this leak was buried at the southeast corner of the "A Courtyard" on the east side of the 201-C Process Building. This unplanned release is not listed in WIDS.

4.1.2.2 Tanks and Vaults. The tanks and vaults in the Semi-Works Aggregate Area include the 241-CX-70, 241-CX-71, and 241-CX-72 Storage Tanks. Data available for evaluating the contents of the tanks include results of sampling and analysis of the 241-CX-70 and 241-CX-71 tank contents and waste disposal inventories for 241-CX-70.

4.1.2.2.1 241-CX-70 Storage Tank. No specific sampling and analysis information of soil and other potentially affected media associated with this waste unit was found in the documents reviewed. However, in 1988, a radiation survey conducted by Hanford personnel showed 1,000,000 dis/min of beta radiation in the bricks and concrete in the ash pile adjacent to this tank. This survey does not reflect the current status of the tank area, which is covered by a plastic "greenhouse" building used for radiation containment while excavating through the ash barrier to the tank. An analysis of the tank sludge solids from the 241-CX-70 Storage Tank was performed in 1991. Results of chemical and radiological analyses on the waste material are shown in Table 4-15. No monitoring wells are located near the tank.

Wastes from the tank were analyzed for classification as a RCRA waste. The waste was classified as a RCRA waste due to corrosivity (D002) due to the presence of sodium hydroxide. The mixed waste was also classified as a RCRA toxicity characteristic waste due to detection of chromium (D007) and as a toxic state-only waste (WT02, dangerous waste).

4.1.2.2.2 241-CX-71 Storage Tank. High levels of radioactivity were reportedly detected in soils overlying the tank during an investigation of the tank contents in 1991. Results of this investigation were not reported in the documents reviewed. An analysis of the tank sludge solids from the 241-CX-71 Storage Tank was performed in 1990. Results of chemical and radiological analyses on the waste material are shown in Table 4-16. No monitoring wells are located near the tank.

4.1.2.2.3 241-CX-72 Storage Tank. This waste unit was surveyed for surface radiation in 1990. The results of this survey indicated 15,000 dis/min of beta radiation in a "speck" within the ash pile. The results of this survey do not reflect the current surface conditions at the site, which has since been covered by a 6.2 m by 12.4 m (20 ft by 41 ft) concrete slab. An excavation was made through the slab in 1991 to access the tank for sampling. No specific sampling and analysis information regarding soil and other

1 potentially affected media associated with this waste unit was found in the documents
2 reviewed. There are no monitoring wells located near the tank.
3

4 **4.1.2.3 Cribs and Drains** The Semi-Works Aggregate Area waste management units in
5 this category are the 216-C-1, 216-C-3, 216-C-4, 216-C-5, 216-C-6, 216-C-7, and 216-C-10
6 Cribs.
7

8 **4.1.2.3.1 216-C-1 Crib.** Soil boring 299-E27-133 was drilled 5 m (16 ft) east of the
9 216-C-1 Crib to conduct gamma logging. This boring was logged only once, in 1984. A
10 review of the log indicates an elevated gamma response, potentially due to radionuclide
11 contamination, at depths between 2 and 12 m (6.5 and 39.3 ft) below the ground surface.
12 The boring is thought to be located outside the boundaries of the crib, thus the elevated
13 response cannot be related directly to either the buried waste or the backfill that was
14 used to fill the upper 1.5 m (4.9 ft) depression which formerly existed at this crib. A
15 surface radiation survey conducted in 1987 indicated that radiation levels were below
16 detection. Radiation surveys have not been conducted at the unit since the crib was
17 decommissioned in 1988.
18

19 **4.1.2.3.2 216-C-3 Crib.** In the documents reviewed, no specific sampling and
20 analysis information regarding soil and other potentially affected media associated with
21 this waste management unit was located. No monitoring wells were identified near this
22 waste management unit. This waste unit is posted for surface radiation; however, a
23 surface radiation survey conducted in 1991 found no radiation above detection limits.
24

25 **4.1.2.3.3 216-C-4 Crib.** No specific sampling and analysis information regarding
26 soil and other potentially affected media associated with this waste unit was found in the
27 documents reviewed. No monitoring wells were identified near this waste management
28 unit. A surface radiation survey conducted in 1988 found no radiation above detection
29 limits.
30

31 **4.1.2.3.4 216-C-5 Crib.** No specific sampling or analysis results for soil or other
32 media were found in the documents reviewed for this waste unit. Monitoring well
33 299-E24-8 is located 20 m (65 ft) south of the crib. Gamma scintillation logs indicated a
34 natural gamma response in 1963 but an elevated gamma response from 0 to 3.1 m (0 to
35 10 ft) below the ground surface in 1968 and 1976. This result was attributed to the
36 presence of a waste transfer line at a distance of 3.1 m (10 ft) from the monitoring well.
37 A surface radiation survey conducted in 1992 found no radiation above detection limits.
38

39 **4.1.2.3.5 216-C-6 Crib.** No specific sampling or analysis results for soil or other
40 media were found in the documents reviewed for this unit. No monitoring wells were
41 identified near this waste management unit. A surface radiation survey conducted in
42 1988 found no radiation above detection limits.

1 **4.1.2.3.6 216-C-7 Crib.** No specific sampling or analysis results for soil or other
2 media were found in the documents reviewed for this waste unit. As discussed in Section
3 4.1.1.5, wastewater discharged to the crib from the 209-E Critical Mass Laboratory was
4 analyzed. Results of this analysis are presented in Table 4-13. No monitoring wells were
5 identified near this waste management unit. A surface radiation survey conducted in
6 1988 found no radiation above detection limits.

7
8 **4.1.2.3.7 216-C-10 Crib.** No specific sampling or analysis results for soil or other
9 media were found in the documents reviewed for this unit. Well 299-E27-5, located 3 m
10 (10 ft) north of this unit, monitors this crib. Gamma scintillation logs made between
11 1963 and 1976 suggest a natural gamma response. A surface radiation survey conducted
12 in 1992 found no radiation above detection limits.

13
14 **4.1.2.3.8 Critical Mass Laboratory Dry Well North.** No information was available
15 on this site in the documents reviewed.

16
17 **4.1.2.3.9 Critical Mass Laboratory Dry Well South.** No information was available
18 on this site in the documents reviewed.

19
20 **4.1.2.3.10 Critical Mass Laboratory Dry Well East.** No information was available
21 on this site in the documents reviewed.

22
23 **4.1.2.3.11 Gatehouse French Drain.** No information was available on this site in
24 the documents reviewed.

25
26 **4.1.2.4 216-C-2 Reverse Well.** Results of radiological analysis of a sediment sample from
27 within this well are shown in Table 4-12. No monitoring wells were identified near this
28 waste management unit. A surface radiation survey was conducted at the unit in 1987.
29 The results showed a reading of 500 ct/min of alpha radiation and nondetectable levels of
30 beta radiation. This survey does not reflect current surface conditions at the site, which
31 has since been covered by an ash barrier.

32
33 **4.1.2.5 Ponds, Ditches, and Trenches.** The waste management units in this category in
34 the Semi-Works Aggregate Area are the 200 East Powerhouse Ditch and the 216-C-9
35 Pond.

36
37 **4.1.2.5.1 200 East Powerhouse Ditch.** No specific sampling or analysis results for
38 soil or other media were found in the documents reviewed for this waste unit. However,
39 analytical results from samples of wastewater discharged to the ditch are shown in Table
40 4-9. No monitoring wells were identified near this waste management unit. This ditch is
41 not posted as a surface radiation site. No surface radiation survey was located for this
42 ditch.

1 **4.1.2.5.2 216-C-9 Pond.** Monitoring well 299-E27-1 was completed 50 m (164 ft)
2 north of this pond. The gamma scintillation data reviewed suggested a natural gamma
3 response in all logs completed from 1959 to 1976. No specific sampling or analysis
4 results for soil or other media were found in the documents reviewed. No surface
5 radiation survey was located for this pond.
6

7 **4.1.2.6 Septic Tanks and Associated Drain Fields.** The waste units in this category are
8 the 2607-E-5 and 2607-E-7A Septic Tanks and Drain Fields. These tanks supported the
9 Critical Mass Laboratory and Mobile Offices. The two septic tanks operate in tandem.
10

11 **4.1.2.6.1 2607-E-5 Septic Tank and Drain Field.** No sampling or analysis
12 information regarding soil and other potentially affected media was located for this unit.
13 No monitoring wells have been constructed for this unit. This waste management unit is
14 not posted as a surface radiation area. No surface radiation survey was located for this
15 unit.
16

17 **4.1.2.6.2 2607-E7A Septic Tank and Drain Field.** No sampling or analysis
18 information regarding soil and other potentially affected media was located for this unit.
19 No surface radiation survey was located for this unit. No monitoring wells have been
20 constructed for this unit. This waste management unit is not posted as a surface
21 radiation area.
22

23 **4.1.2.7 Transfer Facilities, Diversion Boxes, and Pipelines.** This category of waste
24 management units in the Semi-Works Aggregate Area includes Semi-Works Valve Pit,
25 the Critical Mass Laboratory Valve Pit, and the 241-C-154 Diversion Box.
26

27 **4.1.2.7.1 Semi-Works Valve Pit.** No monitoring wells were identified near this
28 waste management unit. No surface radiation surveys were located for this waste unit.
29

30 **4.1.2.7.2 Critical Mass Laboratory Valve Pit.** No monitoring wells were identified
31 near this waste management unit. No surface radiation surveys were located for this
32 valve pit.
33

34 **4.1.2.7.3 241-C-154 Diversion Box.** No monitoring wells were identified near this
35 waste management unit. No surface radiation surveys were located for this unit.
36

37 **4.1.2.8 Basins**

38
39 No basins were identified in the Semi-Works Aggregate Area.
40

4.1.2.9 Burial Sites

4.1.2.9.1 218-C-9 Burial Ground. This category includes only the 218-C-9 Burial Ground. No specific sampling or analysis results for soil or other media were found in the documents reviewed for this burial ground. Monitoring well 299-E27-1 was constructed 50 m (164 ft) north of this burial ground. A natural gamma response was obtained from this monitoring well in all logs completed between 1959 and 1976. Based on a 1990 fitness-for-use evaluation, this well is no longer usable due to damage to the casing and should be abandoned or remediated. A surface radiation survey conducted on this waste management unit in 1991 found no radiation above detection limits. The burial ground is posted for underground radiation.

4.1.2.10 Unplanned Releases. These unplanned release sites include UN-200-E-36, UN-200-E-37, UN-200-E-98, and UN-200-E-141 and two newly identified unplanned releases not included in WIDS data. These two unplanned releases are referred to as the 241-C Waste Line Unplanned Release No. 1 and 241-C Waste Line Unplanned Release No. 2.

4.1.2.10.1 UN-200-E-36. Beta/gamma readings up to 80,000 ct/min were registered. The roadway was flushed with water to remediate the contamination. No monitoring wells were identified near this unplanned release. No specific sampling and analysis information regarding soil and other potentially affected media associated with this unplanned release were located in the documents reviewed. A surface radiation survey conducted in 1990 showed a beta radiation level of 4,000 dis/min and nondetectable levels of smearable alpha.

4.1.2.10.2 UN-200-E-37. This release was located east of the Semi-Works Complex. Beta/gamma readings at the time of release registered 200 mrem/hr. The release was reportedly remediated by sprinkling the roadway with water. No monitoring wells were identified near this unplanned release. No specific sampling and analysis information regarding soil and other potentially affected media associated with this unplanned release was located in the documents reviewed. A surface radiation survey performed in May 1992 reported no detectable radiation at this location. All posting requirements were removed.

4.1.2.10.3 UN-200-E-98. The WIDS (WHC 1992a) concludes that particulate matter containing ^{90}Sr was inadvertently spread to the ground surface. No specific sampling and analysis information regarding soil and other potentially affected media associated with this unplanned release was located in the documents reviewed. No monitoring wells were identified near this unplanned release. No recent surface radiation survey was located for this unplanned release. The area surrounding the 216-C-Z Reverse Well is currently covered by an ash barrier.

1 **4.1.2.10.4 UN-200-E-141.** A uranyl nitrate leakage in 1984 within the 2718
2 Storage Building resulted in this unplanned release. This unplanned release was
3 reportedly remediated to background levels. No monitoring wells were identified near
4 this unplanned release. No specific sampling and analysis information regarding soil and
5 other potentially affected media associated with this unplanned release was not located in
6 the documents reviewed. No surface radiation survey was located for this unplanned
7 release.
8

9 **4.1.2.10.5 241-C Waste Line Unplanned Release No. 1.** A release of radioactive
10 waste from the 241-C Waste Line valve flange was reported in 1957. This leak, which
11 occurred just west of the 201-C Process Building, contaminated soils below the ground
12 surface. Radiation readings of greater than 100 Rad/hr were measured at a depth of
13 3.7 m (12 ft) below the surface. Contaminated soils were reportedly buried at the
14 southeast corner of the "A Courtyard" of 201-C Process Building. This release is within
15 the area currently covered by the ash barrier. No monitoring wells are located near this
16 unplanned release. No recent surface radiation surveys were located for this release.
17

18 **4.1.2.10.6 241-C Waste Line Unplanned Release No. 2.** A second release from
19 the 241-C waste line occurred at a flange near the 241-CX fence at the east side of the
20 Semi-Works Complex. This release, which was also reported in 1957, contaminated
21 subsurface soils along the fence. Radiation levels greater than 100 Rad/hr were reported
22 at a depth of 4.6 m (15 ft). No monitoring wells are located in this area. No recent
23 surface radiation surveys were located for this unplanned release.
24
25

26 **4.2 POTENTIAL IMPACTS TO HUMAN HEALTH AND THE ENVIRONMENT**

27

28 This preliminary assessment is intended to provide a qualitative evaluation of
29 potential human health hazards associated with the known and suspected contaminants at
30 the Semi-Works Aggregate Area. The assessment includes a discussion of release
31 mechanisms and potential transport pathways, develops a conceptual model of human
32 exposure based on these pathways, and presents the physical, radiological, and
33 toxicological characteristics of the known or suspected contaminants.
34

35 In developing the conceptual model, potential exposures to groundwater have not
36 been addressed in detail. Because migration in groundwater is a primary route for
37 potential future exposures to many of the chemicals disposed of at the Hanford Site, this
38 pathway (i.e., travel time, receptors) will be addressed in the 200 East Groundwater
39 AAMS.
40

41 It is important to note that these evaluations do not attempt to quantify potential
42 human health risks associated with exposure to Semi-Works Aggregate Area waste

1 management unit and unplanned release contaminants. Such a risk assessment cannot be
2 performed until additional waste unit characterization data are acquired. Risk
3 assessment activities will be performed in accordance with the *Hanford Site Baseline Risk*
4 *Assessment Methodology* document (DOE/RL 1991) prepared in response to the M-29
5 milestone.

8 4.2.1 Release Mechanisms

10 The Semi-Works Aggregate Area waste management units and unplanned releases
11 can be divided into two general categories based on the nature of the waste released: 1)
12 units and releases where waste was discharged directly to the environment and 2) units
13 and releases where waste was discharged inside a containment structure and must bypass
14 an engineered barrier to reach the environment.

16 In the first group are those waste management units where release of wastes to
17 the soil column was an integral part of the waste disposal strategy. Included in this group
18 are septic system drain fields, cribs and ditches, ponds, reverse wells, and some disposal
19 trenches. Also in this group are unplanned releases that involved waste material released
20 to the soil. For this group of waste management units and unplanned releases, if
21 discharges contained contaminants of concern, it can be assumed that the underlying soils
22 are contaminated. The first task in developing a conceptual model for these units and
23 releases is to determine whether contaminants of concern are retained in soil near the
24 waste management unit or unplanned release, or are likely to migrate to the underlying
25 aquifer and then to receptor points such as drinking water wells or surface water bodies.
26 Factors affecting migration of chemicals away from the point of release will be discussed
27 in the following section.

29 In the second group are waste management units that were intended to act as a
30 barrier to environmental releases. Included in this group are burial grounds that received
31 only solid waste, storage tanks, waste transfer facilities such as piping and diversion
32 boxes, and unplanned releases that occurred within containment structures. For these
33 waste management units and unplanned releases, the first consideration to be addressed
34 in developing a conceptual model is the integrity of the containment structure.

36 The ability of this report to evaluate the efficacy of engineered barriers is limited
37 by the lack of vadose zone soil sampling data and air sampling data for many waste
38 management units and unplanned releases. Available sampling information for the waste
39 management units and unplanned releases has been summarized in Section 4.1. Vadose
40 zone sampling or gamma logging information was available only for the 216-C-1, 216-C-5,
41 and 216-C-10 Cribs; the 216-C-2 Reverse Well; and the 216-C-9 Pond and 218-C-9 Burial
42 Ground.

1 For the 218-C-9 Burial Ground, which received only dry construction debris from
2 the decommissioning of Semi-Works buildings, the potential for release is expected to be
3 low. However, due to the earlier use of this location as a waste disposal pond, it is
4 probable that soils beneath portions of the 218-C-9 Burial Ground are contaminated.

5
6 In addition to evaluating releases to the subsurface, the conceptual model must
7 address the potential for releases to air and, for radionuclides, the potential for direct
8 irradiation. All of the engineered waste management units have some type of barrier to
9 releases to the surface; however, barriers can fail over time or may not be designed to
10 prevent migration by certain transport pathways (e.g., volatilization).

11
12 The primary route for potential migration of contaminants from waste
13 management units to air appears to be via vent pipes. Cribs in the Semi-Works
14 Aggregate Area are constructed with buried perforated pipe covered by a layer of gravel
15 and backfill. Likewise, the three storage tanks are below ground and only fill pipes and
16 risers extend above the surface. No data were located to evaluate the potential for
17 airborne releases from these vents and pipes.

18 19 20 **4.2.2 Transport Pathways**

21
22 Transport pathways that could potentially occur within the Semi-Works Aggregate
23 Area are summarized in this section, including:

- 24
25 • Drainage and leaching from soil to groundwater, or flow through an
26 artificial conduit (e.g., a poorly sealed monitoring well)
- 27
28 • Volatilization from wastes and shallow soils
- 29
30 • Wind erosion of contaminated surface soils and deposition of fugitive dust
31 on soils, plants, and surface water
- 32
33 • Uptake from soils by vegetation
- 34
35 • Uptake from soils by animals via direct contact with soils or ingestion of
36 vegetation
- 37
38 • Direct radiation.

39
40 In addition, transport within the saturated zone and subsequent release to
41 groundwater wells or to off-site surface water (i.e., the Columbia River) is of potential

1 concern, but will not be addressed in this document, since this topic will be the focus of
2 the 200 East Groundwater AAMS.

3
4 **4.2.2.1 Transport from Soils to Groundwater.** Soil is the initial receiving medium for
5 waste discharges in the Semi-Works Aggregate Area, whether the release is directly to
6 soil or through failure of a containment system. Several factors determine whether
7 chemicals that are introduced into the vadose zone will reach the unconfined aquifer,
8 which lies at a depth of approximately 87 m (285 ft) below ground surface. These factors
9 are discussed in the following sections.

10
11 **4.2.2.1.1 Depth of Release.** Waste management units that released wastes at a
12 greater depth below the surface are more likely to contaminate groundwater than waste
13 management units and unplanned releases where the release was shallow. The 216-C-2
14 Reverse Well is a primary example of a deep release at the Semi-Works Aggregate Area.
15 This unit discharged wastes to the vadose zone approximately 12 m (39 ft) below the
16 surface. Other units which extend below the ground surface more than 5 m (16 ft)
17 include the 241-CX-70 and CX-72 Storage Tanks, the 201-C Building cells and the 291-C
18 Stack. No data were located to indicate that releases to the surrounding soil have
19 occurred from these units.

20
21 **4.2.2.1.2 Liquid Volume or Recharge Rate.** For waste constituents to migrate to
22 the underlying water table, some source of recharge must be present. In the Semi-Works
23 Aggregate Area, the primary sources of moisture for mobilizing contaminants are waste
24 management units that discharge liquid waste to the soil column. As discussed in Section
25 3.5.2, estimates of natural precipitation recharge range from 0 to 10 cm/yr (0 to 3.9
26 in./yr), primarily depending on surface soil type, vegetation, and topography. Gravelly
27 surface soils with no or minor shallow rooted vegetation appear to facilitate precipitation
28 recharge. One modelling study (Smoot et al. 1989) indicated that some radionuclide
29 (¹³⁷Cs and ¹⁰⁶Ru) transport could occur with as little as 5 cm/yr (1.95 in./yr) of natural
30 recharge. However, other researchers (Routson and Johnson 1990) have concluded that
31 no net precipitation recharge occurs in the 200 Areas, particularly at waste management
32 units that are capped with fine-grained soils or impermeable covers.

33
34 With respect to artificial recharge, some waste management units (e.g., the
35 216-C-1 Crib) were identified in which the known volume of liquid waste discharged
36 substantially exceeded the total estimated soil pore volume present below the footprint of
37 the facility (Table 4-14). In this case, the moisture content of soil below the waste
38 management units likely approached saturation during the periods of use of these
39 facilities. Because vadose zone hydraulic conductivities are maximized at water contents
40 near saturation, the volume of liquid wastewater historically discharged to the waste
41 management units probably enhanced fluid migration in the vadose zone beneath these
42 units.

1 Contaminants that are not initially transported to the water table by drainage may
2 be mobilized at a later date if a large volume of liquid is added to the unit. In addition,
3 liquids discharged to one unit could mobilize wastes discharged to an adjacent unit if
4 lateral migration takes place within the vadose zone. There are no known cases of this
5 occurring in the Semi-Works Aggregate Area; however, the potential exists. A known
6 example of this process occurred at the U Plant Aggregate Area 216-U-16 Crib, where
7 lateral migration of acidic waste above a caliche layer mobilized radionuclides in the
8 216-U-1 and 216-U-2 Cribs (Baker et al. 1988).

9
10 **4.2.2.1.3 Soil Moisture Transport Properties.** The moisture flux in the vadose
11 zone is dependent on hydraulic conductivity as well as gradients of moisture content or
12 matrix suction. Higher unsaturated hydraulic conductivities are associated with higher
13 moisture contents. However, higher unsaturated hydraulic conductivities may be
14 associated with fine-grained soils compared to coarse-grained soils at low moisture
15 contents. Because of the stratified nature of the Hanford Site vadose zone soils and the
16 moisture content dependence of unsaturated hydraulic conductivity, vertical anisotropy
17 is expected (i.e., vadose zone soils are likely to be more permeable in the horizontal
18 direction than in the vertical). This vertical anisotropy may substantially reduce the
19 potential for contaminant migration to the unconfined aquifer.

20
21 **4.2.2.1.4 Retardation.** The rate at which contaminants will migrate out of a
22 complex waste mixture and be transported through unsaturated soils depends on a
23 number of characteristics of the chemical, the waste, and the soil matrix. In general,
24 chemicals that have low solubilities in the leaching fluid or are strongly adsorbed to soils
25 will be retarded in their migration velocity compared to the movement of soil pore water.
26 Studies have been conducted of soil parameters affecting waste migration at the Hanford
27 Site to attempt to identify the factors that control migration of radionuclides and other
28 chemicals. Recent studies of soil sorption are summarized in Serne and Wood (1990).
29 Some of the processes that have been shown to control the rate of transport are:

- 30
31 • **Adsorption to Soils.** Most contaminants are chemically attracted to some
32 degree to the solid components of the soil matrix. For organic compounds,
33 the adsorption is generally to the organic fraction of the soil, although in
34 extremely low-organic soils, adsorption to inorganic components may be of
35 greater importance. Soil components contributing to adsorption of
36 inorganic compounds include clay minerals, organic matter, and iron and
37 aluminum oxyhydroxides. In general, Hanford Site surface soils are
38 characterized as sandy or gravelly with very low organic content (<0.1
39 percent) and low clay content (<12 percent) (Tallman et al. 1981). Thus,
40 site-specific adsorption factors are likely to be lower, and rate of transport
41 higher, than the average for soils nationwide.
42

- 1 • **Filtration.** Filtration of suspended particulates by fine-grained sediments
2 has been suggested as a mechanism for concentration of radionuclides in
3 certain sedimentary layers. This finding suggests that migration of
4 suspended particulates may be an important mechanism of transport for
5 poorly soluble contaminants.
6
- 7 • **Solubility.** The rate of release of some chemicals is controlled by the rate
8 of dissolution of the chemical from a solid form. The concentration of
9 these chemicals in the pore water will be extremely low, even if they are
10 poorly sorbed. An example cited by Serne and Wood (1990) is the
11 solubility of plutonium oxide, which appears to be the limiting factor
12 controlling the release of plutonium from waste materials at neutral and
13 basic pH.
14
- 15 • **Ionic Strength of Waste.** For some inorganics, the dominant mechanism
16 leading to desorption from the soil matrix is ion exchange. Leachate having
17 high ionic strength (high salt content) can bias the sorption equilibrium
18 toward desorption, leading to higher concentrations of the contaminant in
19 the soil pore water. Examples of wastes within the Semi-Works Aggregate
20 Area that can be considered high ionic strength include liquid Coating
21 Waste from the REDOX and PUREX pilot projects and process
22 condensate from the 201-C Process Building.
23
- 24 • **Waste pH.** The pH of a leachant has a strong effect on inorganic
25 contaminant transport. Acidic leachates tend to increase migration both
26 by increasing the solubility of precipitates and by changing the distribution
27 of charged species in solution. The exact impact of acidic or basic wastes
28 will depend on whether the chemical is normally in cationic, anionic, or
29 neutral form, and the form that it takes at the new pH. Cationic species
30 tend to be more strongly adsorbed to soils than neutral or anionic species.
31 The extent to which addition of acidic leachate will cause a contaminant to
32 migrate will also depend on the buffering or neutralizing capacity of the
33 soil, which is correlated with the calcium carbonate (CaCO_3) content of the
34 soil. The soils in the Hanford formation beneath the Semi-Works
35 Aggregate Area generally have carbonate contents in the range of 0.1 to 5
36 percent. Higher carbonate contents up to 20 percent are observed in finer-
37 grained layers of the Hanford formation.
38

39 Once the leaching solution has been neutralized, the dissolved constituents
40 may re-precipitate or become reabsorbed to the soil. Observations of pH
41 impacts on waste transport at the Hanford Site include:
42

- The remobilization of uranium beneath the 216-U-1 and 216-U-2 Cribs in the U Plant Aggregate Area is believed to have occurred in part because of the introduction of low pH solutions.
- Leaching of americium from the Z Plant Aggregate Area 216-Z-9 Crib sediments was found to be solubility controlled and correlated to solution pH.

4.2.2.1.5 Complexation by Organics. Certain organic materials disposed of at the Semi-Works Aggregate Area are known to form complexes with inorganic ions, which can enhance the solubility and mobility of these ions. Complexing agents known to have been constituents of process wastes at the Semi-Works Aggregate Area include tributylphosphate, EDTA, tetrasodium-EDTA, trisodium hydroxyethyl-EDTA, and nitrilotriacetic acid. In addition, surfactants known to have been used at the site, such as nonylphenoxy polyethoxy ethanol, could affect the migration of inorganic species in the subsurface.

4.2.2.1.6 Contaminant Loss Mechanisms. Processes that can lead to loss of chemicals from soils, and thus decrease the amount of chemical available for leaching to groundwater, include:

- **Radioactive Decay.** Radioactivity decays over time, generally decreasing the quantities and concentrations of radioactive isotopes.
- **Biotransformation.** Microorganisms in the soil may degrade organic contaminants such as kerosene and inorganic chemicals such as nitrate. They may also affect the mobility of metals through reduction-oxidation chemistry and complexation with metabolic products.
- **Chemical Transformation.** Hydrolysis, oxidation, reduction, radiolytic degradation and other chemical reactions are possible degradation mechanisms for contaminants.
- **Vegetative Uptake.** Vegetation may remove chemicals from the soil, bring them to the surface, and introduce them to the food web.
- **Volatilization.** Organic chemicals and volatile radionuclides can be transported in the vapor phase through open pores in soil either to adjacent soil or to the atmosphere. These volatilized compounds could include hexone, radon (a decay product of uranium), and tritium in water (tritiated water). Some elements (mainly fission products such as iodine,

1 ruthenium, cerium, and antimony) are referred to as "semivolatiles" because
2 they have a lesser tendency to volatilize.
3

4 **4.2.2.2 Transport from Soils to Air.** Transport of contaminants from waste management
5 units to the atmosphere can occur by means of vapor transport or by fugitive dust
6 emissions.
7

8 Vapor transport may occur from waste management units or unplanned releases
9 where volatile organics (e.g., chloroform) or volatile radionuclides (^{129}I or ^3H) have been
10 released. Transport mechanisms include diffusion down a concentration gradient and
11 gas-driven flow. Situations where the latter process may occur include production of
12 methane gas from degradation of organic compounds in soil, or production of hydrogen
13 and oxygen gases by radiolytic hydrolysis of water.
14

15 In order for fugitive dust emissions to occur, contaminants must be exposed at the
16 surface of the waste management unit or unplanned release. A number of mechanisms
17 could lead to exposure of contaminants in soil-covered waste management units and
18 unplanned releases. These mechanisms include uptake by vegetation, transport by
19 animals, disruption of the waste management unit or unplanned release (e.g., cave-ins at
20 cribs), and wind erosion. Wind erosion can strip off surface soil and uncover waste
21 materials. The processes by which biota may expose contaminated soils are discussed in
22 Section 4.2.2.4.
23

24 The contribution of the Semi-Works Aggregate Area to the overall fugitive dust
25 emissions at the Hanford Site is expected to be relatively minor, based on results of air
26 monitoring downwind of the Semi-Works Aggregate Area waste management units.
27

28 **4.2.2.3 Transport from Soils to Surface Water.** The only surface water currently
29 identified in the Semi-Works Aggregate Area is at the 200 East Powerhouse Ditch, which
30 receives discharges from the 284-E Power Plant. The former 216-C-9 Pond has not
31 contained water since before 1985.
32

33 Transport of contaminants to surface water bodies outside of the Semi-Works
34 Aggregate Area via groundwater discharge and deposition of fugitive dust on water
35 bodies are the primary pathways of potential concern for surface water effects.
36 Groundwater discharge will be addressed in the 200 East Groundwater AAMS.
37

38 **4.2.2.4 Transport from Soils to Biota.** Biota, plants and animals, have the potential for
39 taking up (bio-uptake), concentrating (bioaccumulating), transporting, and depositing
40 contamination beyond its original extent. Transfer from one species to another in the
41 food chain is also possible because of predation. The possibility of these processes

contributing significantly to the transport of contamination from the Semi-Works Aggregate Area waste management units and unplanned releases is uncertain.

4.2.2.4.1 Uptake by Vegetation. Release of radioactivity to the surface by growth of vegetation is an ongoing problem at Semi-Works Aggregate Area waste management units and unplanned releases. Roots of sagebrush and other native species can take up radionuclides from soils below the surface and transport these chemicals to the foliage. Wind dispersal of portions of the contaminated vegetation, or entire plants (tumbleweeds) can lead to transport of contaminants outside of the unit or release. Westinghouse Hanford has an ongoing vegetation control (herbicide application, reseeding with shallow-rooted vegetation, and mechanical removal) and radiological survey program to prevent radioactivity from being transported by this mechanism. However, the program does not ensure complete removal of vegetation, and incidents of detection of contaminated vegetation are reported occasionally in the radiological surveys.

4.2.2.4.2 Transport by Animals. Disturbance of waste management unit barriers by animals occasionally leads to release of contaminants to the surface. Subsurface soils can be transported to the surface by burrowing animals, thus exposing contaminants for release to the air. Additionally, animals that become contaminated by direct contact with subsurface waste or through ingestion of subsurface contaminants (e.g., chemical salts) and contaminated vegetation, water, or other animals can spread contamination in their feces on the surface and outside of the waste management unit or unplanned release. No examples of this transport mechanism occurring within the Semi-Works Aggregate Area were located; however, one sample of mouse feces collected in the Semi-Works Aggregate Area in 1981 was radioactively contaminated.

4.2.3 Conceptual Model

Figure 4-4 presents a graphical summary of the physical characteristics and mechanisms that have occurred at the site either historically or at present which could potentially affect the generation, transport, and impact of contamination in the Semi-Works Aggregate Area on humans and biota (conceptual model). As discussed in Section 2.3, the various waste management units and unplanned releases in the Semi-Works Aggregate Area were classified into 10 subgroups based on construction, purpose, or origin. In Sections 8.0 and 9.0, the information presented in the body of this report is integrated to identify representative analogue units for additional field work.

The sources of potential contamination include discharges (condensates, cooling water, sewage) from Semi-Works facilities; process wastes from the 201-C Process Building and the Critical Mass Laboratory; drainage from diversion boxes; stack drainage

1 and emissions; debris from decommissioning efforts; low level liquid wastes; low level
2 waste; and waste material that was spilled during transit.

3
4 Contaminants from these sources have been discarded at the waste management
5 units and unplanned releases that are under investigation. These include the 200 East
6 Powerhouse Ditch, cribs, the 216-C-9 Pond, the 218-C-9 Burial Ground, the 216-C-2
7 Reverse Well, storage tanks, septic tanks and drain fields, the Tank Storage Area,
8 diversion boxes and valve pits, and the various unplanned releases that have occurred in
9 the Semi-Works Aggregate Area. These releases and disposal activities are described in
10 Sections 2.0 and 4.1. Some of the unplanned releases are associated with specific waste
11 management units and are shown on Figure 4-4 as dashed lines with "U" designations.

12
13 Waste transfers via intermediate facilities such as transfer lines and between waste
14 units within the Aggregate Area are shown by the arrows to the column marked
15 "Transfer Facilities" and by the vertical arrows in the column marked "Waste Sites",
16 respectively. The primary examples of waste transfer between waste storage and
17 treatment units is the routing of process wastes to the 216-C-1 Crib after neutralization in
18 the 216-CX-71 Tank.

19
20 From the waste management units, various release mechanisms may have
21 transported contamination to the potentially affected media. Volatilization could release
22 chemicals from surface waters into the atmosphere. Chemicals in the 200 East
23 Powerhouse Ditch (and formerly, the 216-C-9 Pond) may have seeped into the vadose
24 zone, or been deposited into the sediments in the ditch. Biota may have taken up
25 contaminants from the surface water and near-surface contaminated soils (via deep roots
26 or burrowing animals).

27
28 Many waste management units discharge their waste effluents directly to the near-
29 surface (vadose zone) soils. The cribs provide seepage discharge and similarly the
30 reverse well and septic system drain fields directly inject their effluents into the
31 subsurface sediments. The unplanned releases have mainly impacted surface soils
32 although some contamination may have also taken place on building surfaces. Fugitive
33 dust from sediment and surface soils has also been released or resuspended due to wind
34 effects or surface disturbances, and some surface soils have been buried or removed to
35 off-site disposal.

36
37 The primary mechanism of vertical contaminant migration is the downward
38 movement of water from the surface through the vadose zone to the unconfined aquifer.
39 The contaminants generally move as a dissolved phase in the water and their rate of
40 migration is controlled both by groundwater movement rates and by adsorption and
41 desorption reactions involving the surrounding sediments. Some contaminants are
42 strongly sorbed on sediments and their downward movement through the stratigraphic

column is greatly retarded. The presence of an artificial conduit, such as a poorly sealed monitoring well, can lead to rapid migration of wastes to the saturated zone. Significant lateral migration of contaminants is restricted to perched water zones and to the unconfined aquifer, where water is moving laterally. Again, adsorption and desorption reactions may greatly retard lateral contaminant migration. Contaminants that were introduced to the soil column outside of the aggregate area may migrate into the area along with perched or aquifer water.

There are four exposure routes by which humans (off site and on site) and other biota (plants and animals) can be exposed to these possible contaminants, including:

- Inhalation of airborne volatiles or fugitive dusts with adsorbed contamination
- Ingestion of surface water, fugitive dust, surface soils, biota (either directly or through the food chain), or groundwater
- Direct contact with the waste materials (such as those exhumed by burrowing animals), contaminated surface soils, buildings, or plants
- Direct radiation from waste materials, surface soils, building surfaces, or fugitive dusts.

4.2.4 Characteristics of Contaminants

Table 4-17 is a list of radioactive and nonradioactive chemical substances that represent candidate contaminants of potential concern for this study based on their known presence in wastes, usage in Semi-Works Aggregate Area processes, disposal in waste management units, historical association with known wastes, or detection in environmental media. Table 4-18 summarizes the types of known or suspected contamination that are thought to exist at the individual waste sites. Known contaminants are those that have been disposed of to the unit based on sampling or inventory data (Tables 2-3 and 2-4) and are known to have impacted environmental media. Suspected contaminants are those which could have been released from the unit based upon historical practices or chemical associations and the engineering characteristics of the unit. Given the large number of chemicals known or suspected to be present, it is appropriate to focus this assessment on those contaminants that are likely to pose a risk to human health or the environment. Table 4-19 lists the contaminants of concern for the Semi-Works Aggregate Area. This list was developed from Table 4-17 and includes only those contaminants which meet the following criteria:

- Radionuclides that have a half-life of greater than one year.
- Radionuclides with a half-life of less than one year which are part of long-lived decay chains that result in the buildup of the short-lived radionuclide activity to a level of 1 percent or greater of the parent radionuclide's activity within the time period of interest.
- Contaminants that are known or suspected carcinogens or have an EPA noncarcinogenic toxicity factor.

The following characteristics will be discussed for the contaminants listed in Table 4-19:

- Detection of contaminants in environmental media
- Historical association with plant activities
- Mobility
- Persistence
- Toxicity
- Bioaccumulation.

4.2.4.1 Detection of Contaminants in Environmental Media. The nature and extent of contamination of surface and subsurface soils, surface water, groundwater, air, and biota have not yet been adequately characterized for the Semi-Works Aggregate Area. All recent environmental monitoring data that could be located were reviewed and summarized for each medium in Section 4.1.

The most extensive monitoring data available are for groundwater. Because groundwater will be evaluated in the 200 East Groundwater AAMS, it will not be discussed further here. Surface soil and biota samples have been collected from locations on a regular rectangular grid. These sampling locations do not correspond to any of the waste management units or unplanned releases, but are intended to characterize the Semi-Works Aggregate Area as a whole. Air and external radiation samples have been collected at several locations within or adjacent to the Semi-Works Aggregate Area. These sampling stations are also not located in close proximity to any of the waste management units or unplanned releases and therefore the sampling results cannot be attributed to releases from any particular unit or release. The only routine sampling data

that correspond directly to waste management units and unplanned releases are the external radiation surveys, which are performed on a regular basis.

4.2.4.2 Historical Association with Semi-Works Activities. Radionuclides and other chemicals that are known to have been used at Semi-Works and are therefore likely components of the waste streams are listed in Table 2-5. This list also includes chemicals reported to occur in the process wastes as well as chemicals that were detected at elevated levels in wastewater. Since these waste streams are known to have been disposed of directly to the soil column via cribs it is probable that the chemicals on this list have affected environmental media.

Based on the WIDS data (WHC 1991a), radionuclides that are known to have been disposed of to Semi-Works Aggregate Area waste management units in the greatest quantities are as follows:

- ^{90}Sr
- ^{137}Cs
- Pu (total)
- ^3H .

Note that a complete radionuclide analysis of the Semi-Works Aggregate Area waste streams is not available. Thus, it is possible that additional radionuclides were discharged to Semi-Works Aggregate Area waste management units and unplanned releases that are not included in the waste inventories presented in Section 2.

Nonradioactive chemicals reportedly released into Semi-Works Aggregate Area waste management units in large quantities include nitric acid, various metallic nitrates, sodium aluminate, sodium nitrate, kerosene, tributylphosphate, and sodium.

4.2.4.3 Mobility. Since some wastes at the Semi-Works Aggregate Area were released directly to subsurface soils via injection, infiltration, or burial, the mobility of the wastes in the subsurface will determine the potential for future exposures. The mobility of the contaminants listed in Table 4-19 varies widely and depends on site-specific factors as well as the intrinsic properties of the contaminant. Much of the site-specific information needed to characterize mobility is not available and will need to be obtained during future field investigations. However, it is possible to make general statements about the relative mobility of the candidate contaminants of concern.

4.2.4.3.1 Transport to the Subsurface. The mobility of radionuclides and other inorganic elements in groundwater depends on the chemical form and charge of the element or molecule, which in turn depends on site-related factors such as the pH, redox state, and ionic composition of the groundwater. Cationic species (e.g., Cd^{2+} , Pu^{4+})

1 generally are retarded in their migration relative to groundwater to a greater extent than
2 anionic species such as nitrate (NO_3^-). The presence in groundwater of complexing or
3 chelating agents can increase the mobility of metals by forming neutral or negatively
4 charged compounds.

5
6 The chemical properties of radionuclides are essentially identical to the
7 nonradioactive form of the element; thus, discussions of the chemical properties affecting
8 the transport of contaminants can apply to both radionuclides and nonradioactive
9 chemicals.

10
11 A soil-water distribution coefficient (K_d) can be used to predict mobility of
12 inorganic chemicals in the subsurface. Table 4-20 presents a summary of soil-water
13 distribution coefficients that have been developed for many of the inorganic chemicals of
14 concern at the Semi-Works Aggregate Area. As discussed above, the pH and ionic
15 strength of the leaching medium has an impact on the absorption of inorganics to soil;
16 thus, the listed K_d s are valid only for a limited range of pH and waste composition. In
17 addition, soil sorption of inorganics is highly dependent on the mineral composition of
18 the soil, the ionic composition of the soil pore water, and other site-specific factors.
19 Thus, a high degree of uncertainty is involved with the use of K_d s that have not been
20 verified by experimentation with site soils.

21
22 Serne and Wood (1990) recommended K_d s for use with Hanford waste
23 assessments for a limited number of important radionuclides (Am, Cs, Co, I, Pu, Ru, Sr,
24 and tritium) based on soil column or batch desorption studies, and have proposed
25 conservative average values for a more extensive list of elements based on a review of
26 the literature. An assumed retardation of <1 is recommended for Am, Cs, Pu, and Sr
27 under acidic conditions.

28
29 Streng and Peterson (1989) developed default K_d s for a large number of
30 elements for use in the Multimedia Environmental Pollution Assessment System
31 (MEPAS), a computerized waste management unit evaluation system. The K_d s were
32 based on findings in the scientific literature, and include non-site-specific as well as
33 Hanford Site values. Values are provided for nine sets of environmental conditions:
34 three ranges of waste pH and three ranges of soil adsorbent material (sum of percent
35 clay, organic material, and metal hydrous oxides). The values presented in Table 4-20
36 are for conditions of neutral waste pH and less than 10 percent adsorbent material,
37 which is likely to be most representative of Hanford Site soils.
38

1 The mobility of inorganic species in soil can be divided roughly into three classes,
2 using site-specific values (Serne and Wood 1990) where available and generic values
3 otherwise: high mobility ($K_d < 5$), moderate mobility ($5 < K_d < 100$), and low mobility
4 chemicals ($K_d > 100$). Table 4-21 lists the mobility class for each of the inorganic
5 contaminants of concern.

6
7 The tendency of organic compounds to adsorb to the organic fraction of soils is
8 indicated by the soil organic matter partition coefficient (K_{oc}). Partition coefficients for
9 the organic chemicals of concern at the Semi-Works Aggregate Area are listed in Table
10 4-22. Chemicals with low K_{oc} values are weakly adsorbed by soils and will tend to
11 migrate in the subsurface, although their rate of travel will be retarded somewhat relative
12 to the pore water or groundwater flow. Soils at the Hanford Site have very little organic
13 carbon content and thus sorption to the inorganic fraction of soils may dominate over
14 sorption to soil organic matter.

15
16 The density of an organic chemical also has an impact on the transport behavior
17 of the chemical. Compounds that are denser than water, such as halogenated solvents
18 (e.g., chloroform), will tend to migrate to the bottom of an aquifer, while compounds that
19 are less dense than water will tend to migrate near the water table.

20
21 **4.2.4.3.2 Transport to Air.** Transport between soils and air can occur either by
22 fugitive dust emissions or volatilization. Chemicals subject to transport via airborne dust
23 dispersion are those that are non-volatile and persistent on the soil surface, including
24 most radionuclides and inorganics, and some organics such as creosote and coal tar.

25
26 Chemicals subject to volatilization are mostly organic compounds; however, some
27 of the radionuclides detected at the site are subject to evaporation and could be lost
28 from shallow soils to the ambient air. The most important species in this category are
29 ^{14}C , ^3H , and ^{129}I .

30
31 The tendency of an organic compound to volatilize can be predicted from its
32 Henry's Law constant (K_h), a measured or calculated parameter with units of
33 atmospheres per mole of chemical per cubic meter. Henry's Law constants of the
34 organic contaminants of concern are presented in Table 4-22. Compounds with a K_h
35 greater than about 10^{-3} will be lost rapidly to the atmosphere from surface water and
36 shallow soils. Organic contaminants of concern for the Semi-Works Aggregate Area that
37 fall into this class include:

- 38
- 39 • Chloroform
- 40 • Tributylphosphate
- 41

1 **4.2.4.4 Persistence.** Once released to environmental media, the concentration of a
2 contaminant may decrease because of biological or chemical transformation, radioactive
3 decay, or the intermediate transfer processes discussed above that remove the chemical
4 from the medium (e.g., volatilization to air). Radiological, chemical, and biological decay
5 processes affecting the persistence of the Semi-Works Aggregate Area contaminants of
6 concern are discussed below.

7
8 The persistence of radionuclides depends primarily on their half-lives. A
9 comparison of the half-lives and specific activities for the radionuclide candidate
10 contaminants of concern for the Semi-Works Aggregate Area is presented in Table 4-23.
11 The specific activity is the decay rate per unit mass, and is inversely proportional to the
12 half-life of the radionuclide. Half-lives for the radionuclides listed in Table 4-23 range
13 from seconds to over one billion years. Also listed are the radiation emissions of primary
14 concern for the radionuclide. Note that radionuclides often emit multiple types of
15 radiation and the daughter products of these decays are often themselves radioactive.

16
17 Decay will occur during transport (e.g., through the vadose zone to the aquifer,
18 through the aquifer) and may lead to significant reductions in levels ultimately reaching
19 off-site areas (e.g., Columbia River). For direct exposures (e.g., to surface soils or air),
20 the half-life of the radionuclide is of less importance, unless the half-life is so short that
21 the radionuclide undergoes substantial decay between the time of disposal and release to
22 the environment.

23
24 Nonradioactive inorganic chemicals detected at the site are generally persistent in
25 the environment, although they may decline in concentration due to transport processes
26 or change their chemical form due to chemical or biological reactions. Nitrate undergoes
27 chemical and biological transformations that may lead to its loss to the atmosphere (as
28 N_2) or incorporation into living organisms, depending on the redox environment and
29 microbiological communities present in the medium.

30
31 Biotransformation rates for organics vary widely and are highly dependent on site-
32 specific factors such as soil moisture, redox conditions, and the presence of nutrients and
33 of organisms capable of degrading the compound. Ketones, such as methyl ethyl ketone,
34 are easily degraded by microorganisms in soil and thus would tend not to persist.
35 Chlorinated solvents (e.g., chloroform) may undergo slow biotransformation in the
36 subsurface under anoxic conditions. Other processes which may affect persistence of
37 organic compounds include phototransformation (in surface soils and waters) and abiotic
38 transformation processes such as hydrolysis and oxidation.

39
40 **4.2.4.5 Toxicity.** Contaminants may be of potential concern for impacts to human health
41 and ecological effects if they are known or suspected to have carcinogenic properties, or

1 if they have adverse noncarcinogenic health effects. The toxicity characteristics of the
2 chemicals detected at the operable unit are summarized below.

3
4 **4.2.4.5.1 Radionuclides.** All radionuclides are classified by EPA as known human
5 carcinogens based on their property of emitting ionizing radiation and on the evidence
6 provided by epidemiological studies of radiation-induced cancers in humans. Non-
7 carcinogenic health effects associated with radiation exposure include genetic and
8 teratogenic effects; however, these effects generally occur at higher exposure levels than
9 those required to induce cancer. Thus, the carcinogenic effect of radionuclides is the
10 primary identified health concern for these chemicals.

11
12 Risks associated with radionuclides differ for various routes of exposure depending
13 on the type of ionizing radiation emitted. Radionuclides that emit alpha or beta particles
14 are hazardous primarily if the materials are inhaled or ingested, since these particles
15 expend their energy within a short distance after penetrating body tissues.
16 Gamma-emitting radioisotopes, which deposit energy over much larger distances, are of
17 concern as both external and internal hazards. A fourth mode of radioactive decay,
18 neutron emission, is generally not of major health concern, since this mode of decay is
19 much less frequent than other decay processes. In addition to the mode of radioactive
20 decay, the degree of hazard from a particular radionuclide depends on the rate at which
21 particles or gamma radiation are released from the material, the degree to which it may
22 concentrate or accumulate in organs of the body following intake, and the length of time
23 it is retained in that organ.

24
25 To illustrate their relative significance, excess cancer risks for exposure to the
26 radionuclide contaminants of concern by inhaling air, drinking water, ingesting soil, and
27 by external irradiation are shown in Table 4-24. These values represent the increase in
28 probability of cancer to an individual exposed for a lifetime to a radionuclide at a level of
29 1 pCi/m³ in air, 1 pCi/L in drinking water, 1 pCi/g in ingested soil, or to external
30 radiation from soil having a radionuclide content of 1 pCi/g (EPA 1991).

31
32 For those radionuclides without EPA (1991) risk factors, the *Hanford Site Baseline*
33 *Risk Assessment Methodology* (DOE/RL 1991) proposes to use the dose conversion
34 factors developed by the International Commission on Radiological Protection to
35 calculate a risk value. In any event, the values shown in Table 4-24 are provided for
36 perspective only, and any Hanford site risk assessments will be performed in accordance
37 with the *Hanford Site Baseline Risk Assessment Methodology* document.

38
39 The unit risk factors for different radionuclides are roughly proportional to their
40 specific activities, but also incorporate factors to account for distribution of each
41 radionuclide within various body organs, the type of radiation emitted, and the length of
42 time that the radionuclide is retained in the organ of interest.

1 Based on the factors listed in Table 4-24, the highest risk for exposure to 1 pCi/m³
2 in air is from plutonium, americium, and uranium isotopes, which are alpha emitters.
3 Among the radionuclide contaminants of concern for the Semi-Works Aggregate Area,
4 the highest risks from ingestion of soil at 1 pCi/g are for ²²⁷Ac, ²⁴¹Am, ²³⁸Pu, ¹²⁹I, ²³¹Pa,
5 ²¹⁰Pb, ²¹⁰Po, ²²³Ra, ²²⁵Ra, ²²⁶Ra, ²²⁹Th, and the uranium isotopes. The primary
6 gamma-emitters are ²¹⁴Bi, ⁶⁰Co, ¹³⁴Cs, ^{137m}Ba, ¹⁵²Eu, ¹⁵⁴Eu, and ²¹⁴Pb.
7

8 The standard EPA risk assessment methodology assumes that the probability of a
9 carcinogenic effect increases linearly with dose at low dose levels, i.e., there is no
10 threshold for carcinogenic response. The EPA methodology also assumes that the
11 combined effect of exposure to multiple carcinogens is additive without regard to target
12 organ or cancer mechanism.
13

14 **4.2.4.5.2 Hazardous Chemicals.** Carcinogenic and non-carcinogenic health effects
15 associated with chemicals detected or disposed of at the Semi-Works Aggregate Area are
16 summarized in Table 4-25.
17

18 The EPA has not derived toxicity criteria for many of the chemicals suspected of
19 being present or detected at the Semi-Works Aggregate Area. Many of the chemicals
20 that lack toxicity criteria have negligible toxicity or are necessary nutrients in the human
21 diet.
22

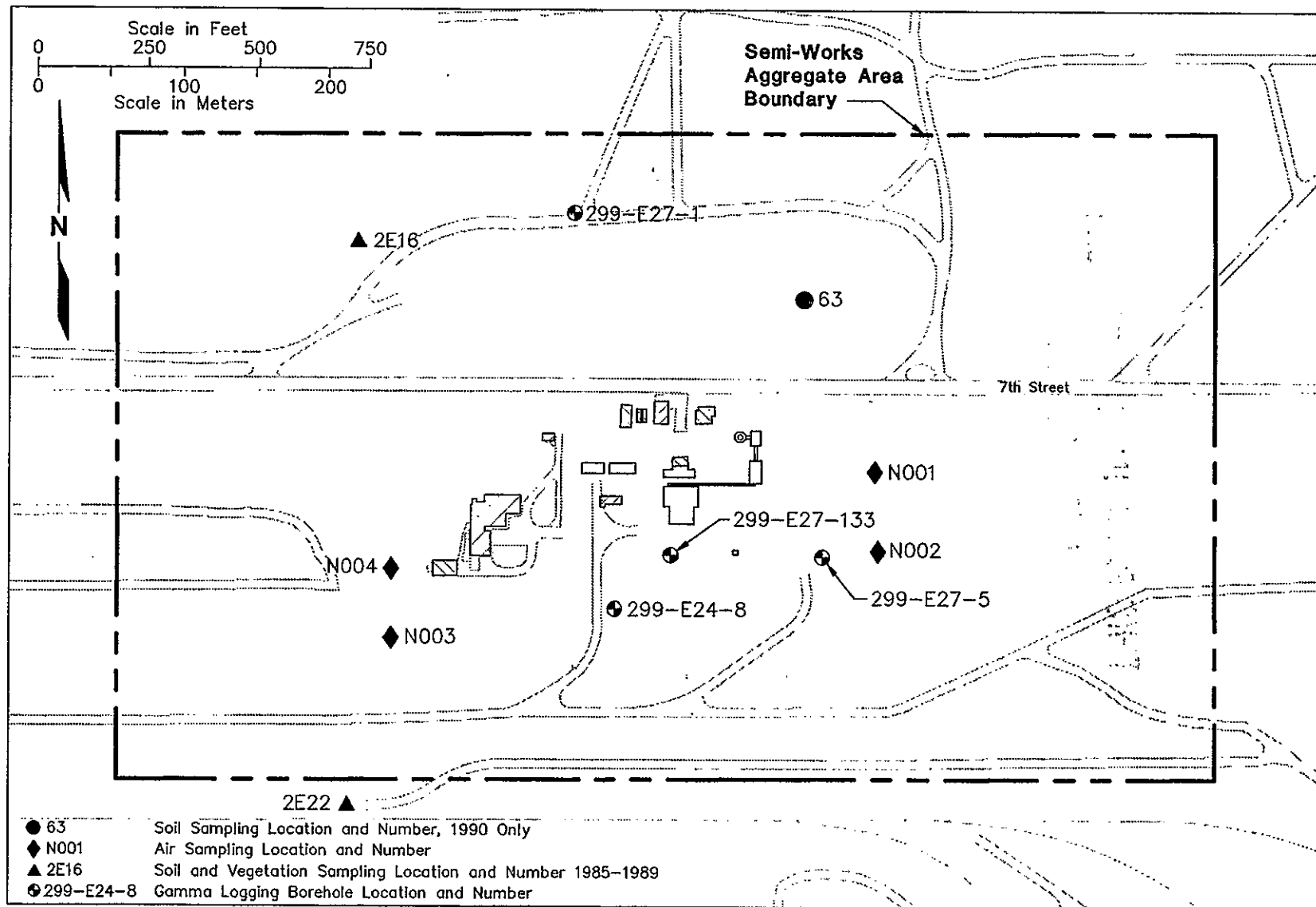
23 Several of the chemicals have known toxic effects but no toxicity criterion is
24 presently available. In some instances the criteria have been withdrawn by EPA pending
25 review of the toxicological data and will be reissued at a future date. Chemicals with
26 known toxicity for which toxicity factors are presently not available include lead,
27 kerosene, tributylphosphate, and uranium.
28

29 **4.2.4.6 Bioaccumulation Potential.** Contaminants may be of concern for exposure if they
30 have a tendency to accumulate in plant or animal tissues at levels higher than those in
31 the surrounding medium (bioaccumulation) or if their levels increase at higher trophic
32 levels in the food chain (biomagnification). Contaminants may be bioaccumulated
33 because of element-specific uptake mechanisms (e.g., incorporation of strontium into
34 bone) or by passive partitioning into body tissues (e.g., concentration of organic chemicals
35 in fatty tissues).
36
37

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9 3 1 2 5 9 3 2 2 4

4F-1

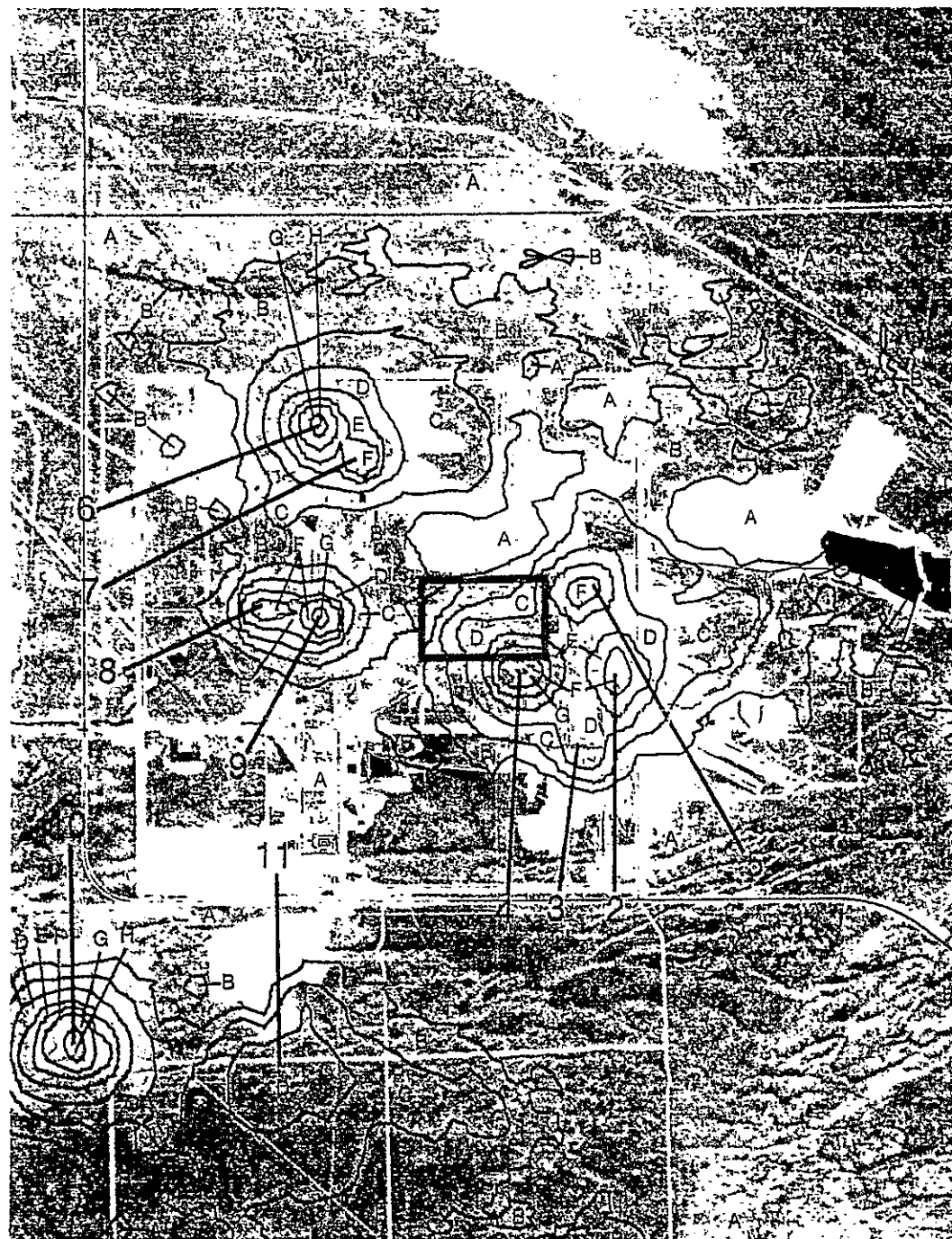


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Figure 4-1. Semi-Works Aggregate Area Surface Media and Air Sampling Locations.

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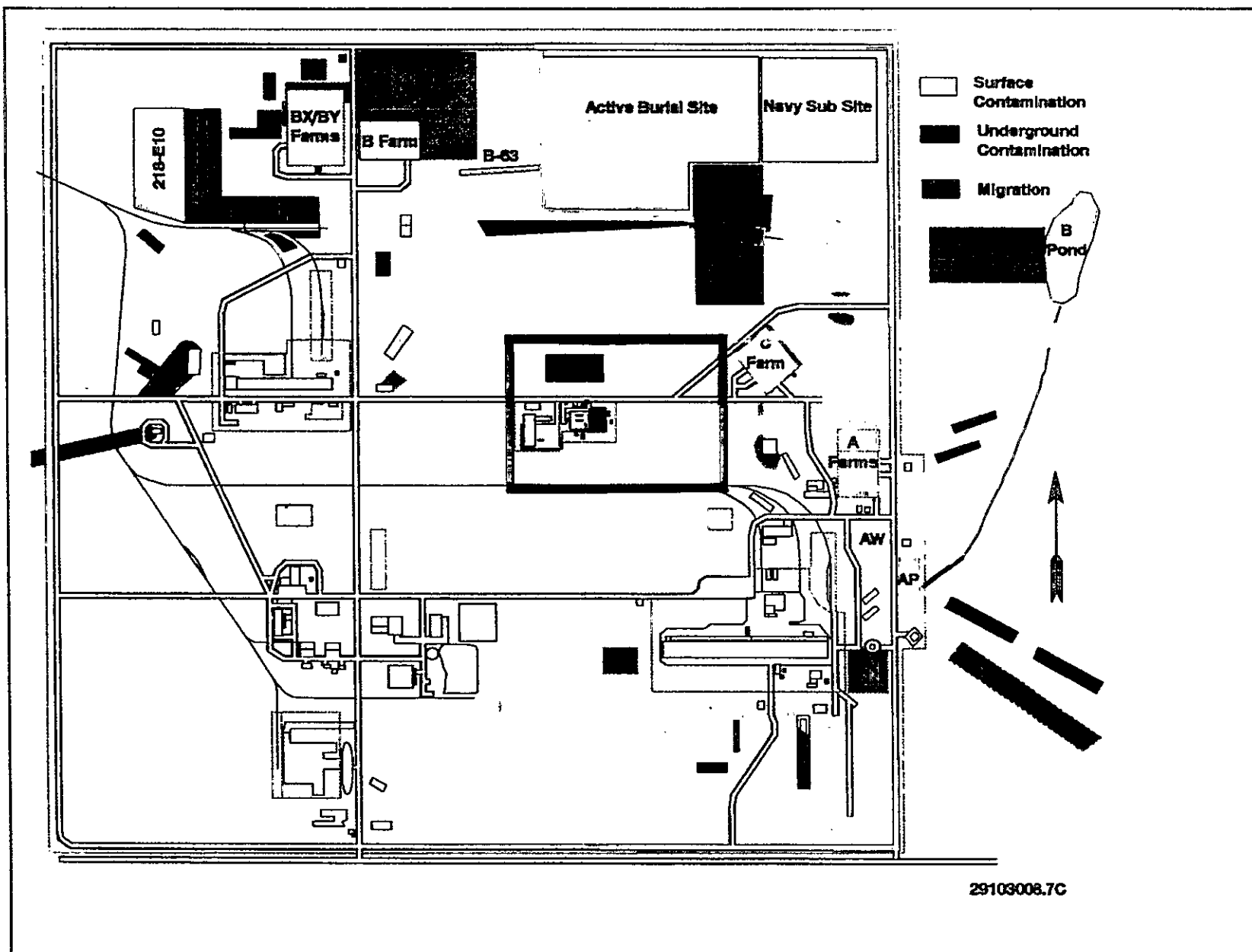
0 400 800 1600 meters

Zone A = <700 ct/s	Zone E = 22,000 to 70,000 ct/s
Zone B = 700 to 2,200 ct/s	Zone F = 70,000 to 220,000 ct/s
Zone C = 2,200 to 7,000 ct/s	Zone G = 220,000 to 700,000 ct/s
Zone D = 7,000 to 22,000 ct/s	Zone H = 700,000 to 2,200,000 ct/s

Numbers refer to sites outside the Semi-Works Aggregate Area.
Semi-Works Aggregate Area is outlined in red.
The results are displayed as relative levels of man-made radionuclide activity.

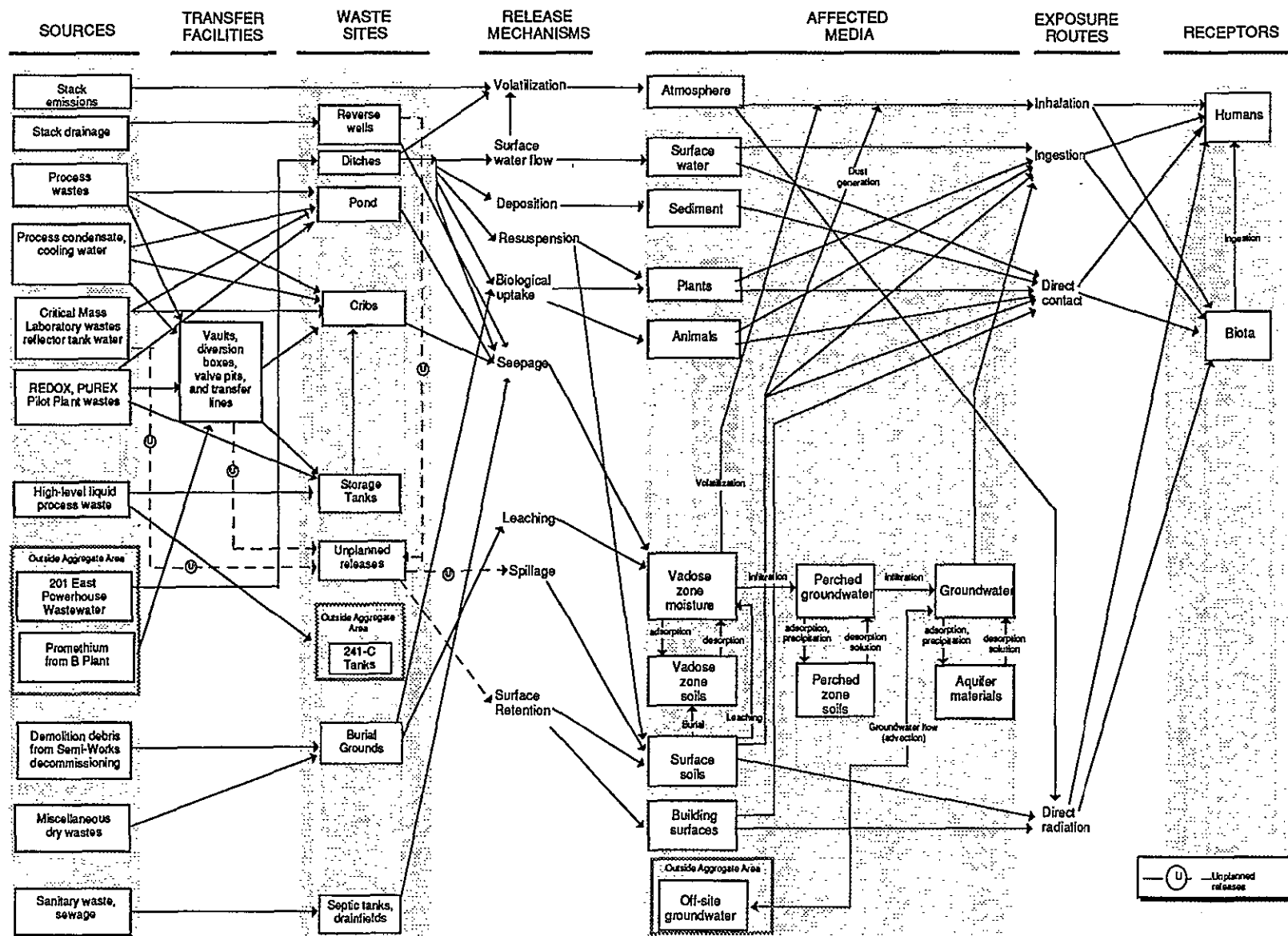
Figure 4-2. Gamma Isoradiation Contour Map of the 200 East Area (Reiman and Dahlstrom 1988).

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Semi-Works Aggregate Area is outlined in red.

Figure 4-3. Surface, Underground, and Migrating Contamination Map of the 200 East Area (Huckfeldt 1991).



297835/April 29, 1992

Figure 4-4. Conceptual Model.

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Table 4-1. Types of Data for the Semi-Works Aggregate Area Waste Management Units. (Sheet 1 of 3)

Waste Management Unit	Waste Inventory Database (WIDS)*	Surface Soil/Sediment Data	External Radiation Monitoring Data	Biota Sampling Data	Subsurface Vapor/Soil Sampling Data	Borehole Geophysics Data
Plants, Buildings, and Storage Areas						
201-C Process Building	R					
291-C Ventilation System	R					
Tanks and Vaults						
241-CX-70 Storage Tank	C,R		R			
241-CX-71 Storage Tank	C,R		R			
241-CX-72 Storage Tank	R		R			
Cribbs and Drains						
216-C-1 Crib	C,R		R			R
216-C-3 Crib	C,R		R			
216-C-4 Crib	C,R		R			
216-C-5 Crib	C,R		R			R
216-C-6 Crib	C,R		R			
216-C-7 Crib	C,R		R			
216-C-10 Crib	R		R			R
Critical Mass Laboratory Dry Well North						

4T-1a

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Table 4-1. Types of Data for the Semi-Works Aggregate Area Waste Management Units. (Sheet 2 of 3)

Waste Management Unit	Waste Inventory Database (WIDS)*	Surface Soil/Sediment Data	External Radiation Monitoring Data	Biota Sampling Data	Subsurface Vapor/Soil Sampling Data	Borehole Geophysics Data
Critical Mass Laboratory Dry Well South						
Critical Mass Laboratory Dry Well East						
Gatehouse French Drain						
Reverse Wells						
216-C-2 Reverse Well			R			
Ponds, Ditches, and Trenches						
216-C-9 Pond	R					R
200 East Powerhouse Ditch						
Septic Tanks and Associated Drain Fields						
2607-E-5 Septic Tank and Drain Field						
2607-E-7A Septic Tank and Drain Field						
Transfer Facilities, Diversion Boxes, and Pipelines						
Semi-Works Valve Pit						
Critical Mass Laboratory Valve Pit						
241-C-154 Diversion Box						
Burial Sites						
218-C-9 Burial Ground	R		R			R

4T-1b

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Table 4-1. Types of Data for the Semi-Works Aggregate Area Waste Management Units. (Sheet 3 of 3)

Waste Management Unit	Waste Inventory Database (WIDS)*	Surface Soil/Sediment Data	External Radiation Monitoring Data	Biota Sampling Data	Subsurface Vapor/Soil Sampling Data	Borehole Geophysics Data
Unplanned Releases						
UN-200-E-36			R			
UN-200-E-37			R			
UN-200-E-98						
UN-200-E-141						
241-C Waste Line Unplanned Release No. 1						
241-C Waste Line Unplanned Release No. 2						

Notes:

C Nonradioactive organic or inorganic constituents

R Radiological constituents

* or other sources of waste inventory information

Blank entry indicates no applicable data found during document review.

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Table 4-2. Summary of Radionuclide Contamination in Various Affected Media for the Semi-Works Aggregate Area. (Sheet 1 of 3)

Waste Management Unit	Air	Surface Soil (0 to 1 m) (0 to 3.2 ft)	Surface Water	Biota	Vadose Zone	Remarks
Plants, Buildings, and Storage Areas						
201-C Process Building		S				Surface radiation in ash pile
291-C Ventilation System		S				Surface radiation in ash pile
Tanks and Vaults						
241-CX-70 Storage Tank						
241-CX-71 Storage Tank					S	
241-CX-72 Storage Tank						
Cribs and Drains						
216-C-1 Crib		nc		s	k	Elevated gamma to 12 m (39 ft)
216-C-3 Crib		nc		s	k	
216-C-4 Crib		nc		s	k	
216-C-5 Crib		nc		s	k	
216-C-6 Crib		nc		s	k	
216-C-7 Crib		nc				Received reflector tank water
216-C-10 Crib		nc		s	k	

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Table 4-2. Summary of Radionuclide Contamination in Various Affected Media for the Semi-Works Aggregate Area. (Sheet 2 of 3)

Waste Management Unit	Air	Surface Soil (0 to 1 m) (0 to 3.2 ft)	Surface Water	Biota	Vadose Zone	Remarks
Critical Mass Laboratory Dry Well North						
Critical Mass Laboratory Dry Well South						
Critical Mass Laboratory Dry Well East						
Gatehouse French Drain		S			S	Drain is labeled as radioactive
Reverse Wells						
216-C-2 Reverse Well		k			k	Elevated external radiation
Ponds, Ditches, and Trenches						
216-C-9 Pond					k	
200 East Powerhouse Ditch						Received 200 E Power Plant wastewater
Septic Tanks and Associated Drain Fields						
2607-E-5 Septic Tank and Drain Field					nc	Sanitary wastes only
2607-E-7A Septic Tank and Drain Field					nc	Sanitary wastes only
Transfer Facilities, Diversion Boxes, and Pipelines						
Semi-Works Valve Pit						
Critical Mass Laboratory Valve Pit						
241-C-154 Diversion Box						
Burial Sites						
218-C-9 Burial Ground		nc			s	

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Table 4-2. Summary of Radionuclide Contamination in Various Affected Media for the Semi-Works Aggregate Area. (Sheet 3 of 3)

Waste Management Unit	Air	Surface Soil (0 to 1 m) (0 to 3.2 ft)	Surface Water	Biota	Vadose Zone	Remarks
Unplanned Releases						
UN-200-E-36		k			s	Elevated surface radiation in 1990
UN-200-E-37		k			s	Elevated surface radiation (historical)
UN-200-E-98		s, r?			s	Elevated surface radiation (historical)
UN-200-E-141		r				Elevated surface radiation (historical)
241-C Waste Line Unplanned Release No. 1					s	Elevated underground radiation (historical)
241-C Waste Line Unplanned Release No. 2					s	Elevated underground radiation (historical)

Notes:

s Suspected contamination, based on WIDS, other waste inventory data, and available sampling and analysis information.

k Known contamination based on WIDS, or other source.

r Complete remediation reported.

r? Remediation attempted, effectiveness not documented.

nc No contamination indicated by the available data.

Blank entries indicate no applicable data found during document review.

4T-2c

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Table 4-3. Summary of Chemical Contamination for Various Affected Media for the Semi-Works Aggregate Area. (Sheet 1 of 3)

Waste Management Unit	Air	Surface Soil (0 to 1 m) (0 to 3.2 ft)	Surface Water	Biota	Vadose Zone Soil (0 to 5 m) (0 to 16 ft)	Remarks
Plants, Buildings, and Storage Areas						
201-C Process Building					S	2.5 tons of lead is entombed in the site
291-C Ventilation System						
Tanks and Vaults						
241-CX-70 Storage Tank						
241-CX-71 Storage Tank						
241-CX-72 Storage Tank						
Cribs and Drains						
216-C-1 Crib					k	
216-C-3 Crib					k	
216-C-4 Crib					k	
216-C-5 Crib					k	
216-C-6 Crib					k	
216-C-7 Crib					k	Received reflector tank water
216-C-10 Crib					k	
Critical Mass Laboratory Dry Well North						

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Table 4-3. Summary of Chemical Contamination for Various Affected Media for the Semi-Works Aggregate Area. (Sheet 2 of 3)

Waste Management Unit	Air	Surface Soil (0 to 1 m) (0 to 3.2 ft)	Surface Water	Biota	Vadose Zone Soil (0 to 5 m) (0 to 16 ft)	Remarks
Critical Mass Laboratory Dry Well South						
Critical Mass Laboratory Dry Well East						
Gatehouse French Drain						
Reverse Wells						
216-C-2 Reverse Well					k	
Ponds, Ditches, and Trenches						
216-C-9 Pond					k	
200 East Powerhouse Ditch			s	s	s	
Septic Tanks and Associated Drain Fields						
2607-E-5 Septic Tank and Drain Field						Sanitary wastes only
2607-E-7A Septic Tank and Drain Field						Sanitary wastes only
Transfer Facilities, Diversion Boxes, and Pipelines						
Semi-Works Valve Pit						
Critical Mass Laboratory Valve Pit						
241-C-154 Diversion Box						
Burial Sites						
218-C-9 Burial Ground						
Unplanned Releases						
UN-200-E-36						
UN-200-E-37						

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Table 4-3. Summary of Chemical Contamination for Various Affected Media for the Semi-Works Aggregate Area. (Sheet 3 of 3)

Waste Management Unit	Air	Surface Soil (0 to 1 m) (0 to 3.2 ft)	Surface Water	Biota	Vadose Zone Soil (0 to 5 m) (0 to 16 ft)	Remarks
UN-200-E-98						
UN-200-E-141						
241-C Waste Line Unplanned Release No. 1		S			S	
241-C Waste Line Unplanned Release No. 2		S			S	

Notes:

s Suspected contamination, based on WIDS, other waste inventory data, and available sampling and analysis information.

k Known contamination based on WIDS, or other source.

r Complete remediation reported.

r? Remediation attempted, effectiveness not documented.

nc No contamination indicated by the available data.

Blank entries indicate no applicable data found during document review.

Table 4-4. Summary of Air Sampling Results (1985 through 1989).

Radionuclide in pCi/m ³	Sampling Location Number			
	N001	N002	N003	N004
Strontium-90	6.0E-04	3.7E-04	6.8E-04	4.2E-04
Cesium-137	9.0E-06	9.0E-06	3.5E-04	7.9E-04
Plutonium- 239	6.5E-06	2.4E-05	3.3E-06	7.9E-06
Uranium (Total)	1.2E-05	4.7E-07	1.3E-05	5.6E-05

Notes:

Table values are annual averages for radionuclide concentrations in air from 1985 through 1989 in pCi/m³.

Shaded values indicate a positive detection result greater than measurement error.

See Table A-1 for complete data set.

See Figure 4-1 for sampling locations.

Table 4-5. Radiation and Dose Rate Surveys at the Semi-Works Aggregate Area Waste Management Units. (Sheet 1 of 4)

			Radiation Survey				Radiation Type, Notes
Waste Management Unit	Ref.	Inspection Date	ct/min	dis/min	mrem/hr	Smearable Alpha in dis/min	
Plants, Buildings, and Storage Areas							
201-C Process Building	2	1983	NA	NA	2.5 to 1500	NA	α , β , γ in cells at ground level covered by ash barrier
291-C Ventilation System	2	1988	350	NA	NA	NA	α , β , γ in entombed filter unit and housing currently covered by ash barrier
Tanks and Vaults							
241-CX-70 Storage Tank	1	4/16/91	NA	17,000	NA	420	β , bricks & concrete in ash pile; does not reflect current surface conditions
241-CX-71 Storage Tank							
241-CX-72 Storage Tank	1	12/5/90	NA	15,000	ND	NA	β , "speck" in ash pile area; does not reflect curent surface conditions
Cribs and Drains							
216-C-1 Crib	1	3/30/87	ND	ND	NA	ND	Decommissioned in 1988. No longer surveyed.
216-C-3 Crib	1	2/27/91	ND	ND	ND	ND	
216-C-4 Crib	1	8/30/88	NA	ND	ND	ND	
216-C-5 Crib	1	2/27/92	NA	ND	NA	NA	
216-C-6 Crib	1	3/30/88	NA	ND	NA	ND	
216-C-7 Crib	1	8/30/88	NA	ND	ND	ND	

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Table 4-5. Radiation and Dose Rate Surveys at the Semi-Works Aggregate Area Waste Management Units. (Sheet 2 of 4)

			Radiation Survey				Radiation Type, Notes
Waste Management Unit	Ref.	Inspection Date	ct/min	dis/min	mrem/hr	Smearable Alpha in dis/min	
216-C-10 Crib	1	2/28/92	NA	ND	ND	NA	
Critical Mass Laboratory Dry Well North							
Critical Mass Laboratory Dry Well South							
Critical Mass Laboratory Dry Well East							
Gatehouse French Drain							Drain is labeled as radioactive - type unknown
Reverse Wells							
216-C-2 Reverse Well	1	3/30/87	500	ND	ND	ND	Currently covered by ash barrier
Ponds, Ditches, and Trenches							
216-C-9 Pond							
200 East Powerhouse Ditch							

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Table 4-5. Radiation and Dose Rate Surveys at the Semi-Works Aggregate Area Waste Management Units. (Sheet 3 of 4)

			Radiation Survey				Radiation Type, Notes
Waste Management Unit	Ref.	Inspection Date	ct/min	dis/min	mrem/hr	Smearable Alpha in dis/min	
Septic Tanks and Associated Drain Fields							
2607-E-5 Septic Tank and Drain Field							
2607-E-7A Septic Tank and Drain Field							
Transfer Facilities, Diversion Boxes, and Pipelines							
Semi-Works Valve Pit							
Critical Mass Laboratory Valve Pit							
241-C-154 Diversion Box							
Burial Sites							
218-C-9 Burial Ground	1	4/12/91	NA	ND	NA	NA	
Unplanned Releases							
UN-200-E-36	3	11/15/90	NA	ND	ND	ND	β , γ , remediation attempted
UN-200-E-37	1	5/20/92	NA	ND	NA	ND	β , γ , remediation attempted
UN-200-E-98	2	1980	NA	NA	NA	NA	Unknown level of ^{90}Sr , partially remediated

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Table 4-5. Radiation and Dose Rate Surveys at the Semi-Works Aggregate Area Waste Management Units. (Sheet 4 of 4)

			Radiation Survey				Radiation Type, Notes
Waste Management Unit	Ref.	Inspection Date	ct/min	dis/min	mrem/hr	Smearable Alpha in dis/min	
UN-200-E-141	2	1984	NA	NA	NA	NA	Spill of ²³⁵ U, level unknown. Remediated to background.
241-C Waste Line Unplanned Release No. 1		1957	to 80,000	NA	NA	NA	Underground pipe leak, >100 rem at 3 m (12 ft) depth
241-C Waste Line Unplanned Release No. 2		1957	to 80,000	NA	NA	NA	Underground pipe leak, >100 rem at 5 m (15 ft)

Notes:

Refs: 1) Compilation of Radiation Survey Data for the Semi-Works Aggregate Area
 2) Technical Baseline Report
 3) March 1992 Survey

ND Measured but not detected

NA Parameter was not available (not measured) in most recent survey

ct/min Counts per minute

dis/min Disintegrations per minute

mrem/hr Millirem per hour

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Table 4-6. Results of External Radiation Monitoring: TLD Readings

Sample Location	Readings in mrem/yr						Annual Average
	1985	1986	1987	1988	1989	1990 ^b	
2E16							
	max	83	106	103	114	a	102
	min	64	70	87	93	a	79
	total	74	83	93	107	a	89
2E22							
	max	a	104	102	113	a	106
	min	a	81	83	70	a	78
	total	a	88	94	98	a	93

Notes:

(a) Sample not taken at this location

(b) Sample locations were changed in 1990. None of the new locations were within the Semi-Works Aggregate Area.

Monthly/quarterly dose rates normalized to annual dose rate equivalent.

max - maximum quarterly value reported.

min - minimum quarterly value reported.

total - Annual average value reported.

Data Sources: Elder et al. 1986 through 1989, Schmidt et al. 1990 and 1992.

See Figure 4-1 and Plate 2 for sample locations.

Table 4-7. Summary of Grid Soil Sampling Results (1985-1989)

Radionuclide Average Concentration in pCi/g	Sample Location	
	2E16	2E22
Cerium-141	6.7E-03	
Cerium-144	-6.0E-02	-1.1E-02
Cobalt-58	6.8E-03	4.4E-03
Cobalt-60	1.2E-02	8.6E-03
Cesium-134	2.8E-02	8.0E-03
Cesium-137	3.7E+00	2.3E+00
Europium-152	1.1E-01	1.1E-01
Europium-154	-5.0E-03	2.3E-02
Europium-155	-1.6E-02	6.9E-02
Iodine-129		
Potassium-40		
Manganese-54	2.2E-02	1.3E-02
Niobium-95		
Lead-212		
Lead-214	6.6E-01	7.8E-01
Plutonium-238	1.2E-03	1.2E-03
Plutonium-239	9.4E-02	1.6E-01
Ruthenium-106	1.1E-01	-8.8E-02
Strontium-90	1.8E+00	5.2E-01
Technetium-99		
Uranium	3.8E-01	3.9E-01
Zinc-65	-4.3E-02	-4.3E-02
Zirconium-95	4.4E-02	2.5E-02

Notes:

Concentrations reported are averages for all years that the location was sampled.

Blanks indicate radionuclide not analyzed, or results not reported.

Shaded values indicate a positive detection, results are greater than the measurement error of the analytical method.

Negative values indicate concentrations at or near background levels of radioactivity.

Data Sources:

Rockwell Hanford Operations Environmental Surveillance Annual Monitoring Reports -- 200/600 Areas (1985 and 1986).

Westinghouse Hanford Operations Environmental Surveillance Annual Monitoring Reports -- 200/600 Areas (1987 through 1990).

Table 4-8. Results of Grid Soil Sampling, 1990
Sample Location 63

Radionuclide in pCi/g Dry Weight	Result	Error
Antimony-125	6.54E-02	6.70E-02
Beryllium-7	-1.87E+01	2.99E+01
Cerium-144	3.61E-02	6.45E-01
Cobalt-60	-1.93E-02	2.71E-02
Cesium-134	-4.84E-02	2.67E-02
Cesium-137	5.50E-01	7.00E-02
Europium-154	-7.23E-03	7.14E-02
Europium-155	5.14E-02	7.88E-02
Potassium-40	1.48E+01	1.67E+00
Lead-212	8.14E-01	9.41E-02
Lead-214	8.47E-01	1.07E-01
Plutonium-238	3.07E-04	3.42E-04
Plutonium-239/240 ⁽¹⁾	3.08E-02	4.41E-03
Radium-226	7.39E-01	9.98E-02
Ruthenium-106	3.68E-01	3.23E-01
Strontium-90	1.63E+00	3.02E-01
Uranium	9.21E-01	1.27E-01
Uranium-235	3.41E-02	1.91E-02
Uranium-238	8.28E-01	1.16E-01
Zinc-65	-4.74E-01	1.90E-01
Zirconium/Niobium-95 ⁽¹⁾	2.25E-01	3.78E+00

Notes:

- (1) Radionuclides cannot be distinguished.
 (2) Shaded values indicate a positive detection, results are greater than the counting error of the measurement.
 (3) Negative values indicate concentrations at or near background levels of radioactivity.

Source: Schmidt et al., 1992

Table 4-9. Analysis of 284-E Power Plant Wastewater.

Constituent	Mean Concentration	Maximum Concentration
Aluminum, in $\mu\text{g/liter}$	3.64E+02	8.74E+02
Arsenic (EP Toxic), $\mu\text{g/liter}$	<5.00E+02	<5.00E+02
Barium, in $\mu\text{g/liter}$	6.02E+01	9.60E+01
Barium (EP Toxic), in $\mu\text{g/liter}$	<1.00E+03	<1.00E+03
Boron, in $\mu\text{g/liter}$	5.25E+01	6.20E+01
Cadmium (EP Toxic), in $\mu\text{g/liter}$	<1.00E+02	<1.00E+02
Calcium, in $\mu\text{g/liter}$	1.96E+04	2.09E+04
Chloride, in $\mu\text{g/liter}$	3.70E+03	6.00E+03
Chromium (EP Toxic), in $\mu\text{g/liter}$	<5.00E+02	<5.00E+02
Fluoride, in $\mu\text{g/liter}$	1.57E+02	1.86E+02
Iron, in $\mu\text{g/liter}$	1.54E+02	3.30E+02
Lead (EP Toxic), in $\mu\text{g/liter}$	<5.00E+02	<5.00E+02
Magnesium, in $\mu\text{g/liter}$	4.34E+03	4.44E+03
Manganese, in $\mu\text{g/liter}$	5.50E+00	7.00E+00
Mercury (EP Toxic), in $\mu\text{g/liter}$	<2.00E+01	<2.00E+01
Nitrate, in $\mu\text{g/liter}$	5.25E+02	6.00E+02
Potassium, in $\mu\text{g/liter}$	8.56E+02	1.04E+03
Selenium (EP Toxic), in $\mu\text{g/liter}$	<5.00E+02	<5.00E+02
Silicon, in $\mu\text{g/liter}$	3.10E+03	4.06E+03
Silver (EP Toxic), in $\mu\text{g/liter}$	<5.00E+02	<5.00E+02
Sodium, in $\mu\text{g/liter}$	9.04E+03	1.38E+04
Strontium, in $\mu\text{g/liter}$	2.40E+02	2.65E+02
Sulfate, in $\mu\text{g/liter}$	1.71E+04	1.99E+04
Uranium, in $\mu\text{g/liter}$	4.72E-01	6.18E-01
Zinc, in $\mu\text{g/liter}$	7.25E+00	1.30E+01
Ammonia, in $\mu\text{g/liter}$	5.35E+01	5.80E+01
1-Butanol, in $\mu\text{g/liter}$	1.80E+01	1.80E+01
Trichloromethane, in $\mu\text{g/liter}$	1.55E+01	2.60E+01
Total alpha, in pCi/L	8.98E-01	1.22E+00
Total beta, in pCi/L	1.80E+00	2.75E+00

Table 4-10. Summary of Grid Vegetation Sampling Results (1985-1989).

Radionuclide Average Concentration in pCi/g	Sample Location	
	2E16	2E22
Cerium-141	-2.8E-02	4.2E-02
Cerium-144		
Cobalt-58		
Cobalt-60	6.3E-03	2.3E-02
Cesium-134	1.7E-01	2.5E-01
Cesium-137	3.7E-01	3.4E-01
Europium-152	4.5E-02	1.3E-02
Europium-154	6.7E-03	2.5E-02
Europium-155	1.2E-02	8.9E-03
Iodine-129		
Potassium-40		
Manganese-54		
Niobium-95	-3.8E-02	-1.8E-02
Lead-212		
Lead-214		
Plutonium-238		
Plutonium-239		
Ruthenium-103	3.3E-01	2.4E-01
Ruthenium-106	4.8E-01	7.8E-01
Strontium-90		
Technetium-99		
Uranium		
Zinc-65		
Zirconium-95	2.3E-02	1.5E-02

Concentrations reported are averages for all years that the location was sampled.

Blanks indicate radionuclide not analyzed, or results not reported.

Shaded values indicate positive detection, results are greater than measurement error of analytical method.

Negative values indicate concentrations at or near background levels of radioactivity.

Data Sources:

Rockwell Hanford Operations Environmental Surveillance Annual Monitoring Reports -- 200/600 Areas (1985 and 1986).

Westinghouse Hanford Operations Environmental Surveillance Annual Monitoring Reports -- 200/600 Areas (1987 through 1990).

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Table 4-11. Summary of Gamma Scintillation Logging Results. (Sheet 1 of 2)

Waste Management Unit	Well Number	Relative Location	Remarks
Plants, Buildings, and Storage Areas			
201-C Process Building	No monitoring wells		
291-C Ventilation System	No monitoring wells		
Tanks and Vaults			
241-CX-70 Storage Tank	No monitoring wells		
241-CX-71 Storage Tank	No monitoring wells		
241-CX-72 Storage Tank	No monitoring wells		
Cris and Drains			
216-C-1 Crib	299-E27-133	5 meters east of crib	Elevated gamma response between 2 and 12 meters below land surface.
216-C-3 Crib	No monitoring wells		
216-C-4 Crib	No monitoring wells		
216-C-5 Crib	299-E24-8	20 meters south of crib	Elevated gamma between 0-3 m probably due to waste transfer line 3.2m from well. (Fecht et. al 1977)
216-C-6 Crib	No monitoring wells		
216-C-7 Crib			
216-C-10 Crib	299-E27-5	3 meters north of crib	Natural gamma response.
Critical Mass Laboratory Dry Well North	No monitoring wells		
Critical Mass Laboratory Dry Well South	No monitoring wells		
Critical Mass Laboratory Dry Well East	No monitoring wells		
Gatehouse French Drain	No monitoring wells		

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Table 4-11. Summary of Gamma Scintillation Logging Results. (Sheet 2 of 2)

Waste Management Unit	Well Number	Relative Location	Remarks
Reverse Wells			
216-C-2 Reverse Well	No monitoring wells		
Ponds, Ditches, and Trenches			
216-C-9 Pond	299-E27-1	50 meters north of pond	Natural gamma response.
200 East Powerhouse Ditch	No monitoring wells		
Septic Tanks and Associated Drain Fields			
2607-E-5 Septic Tank and Drain Field	No monitoring wells		
2607-E-7A Septic Tank and Drain Field	No monitoring wells		
Transfer Facilities, Diversion Boxes, and Pipelines			
Semi-Works Valve Pit	No monitoring wells		
Critical Mass Laboratory Valve Pit	No monitoring wells		
241-C-154 Diversion Box	No monitoring wells		
Burial Sites			
218-C-9 Burial Ground	299-E27-1	50 meters north of burial ground	Natural gamma response.
Unplanned Releases			
UN-200-E-36	No monitoring wells		
UN-200-E-37	No monitoring wells		
UN-200-E-98	No monitoring wells		
UN-200-E-141	No monitoring wells		
241-C Waste Line Unplanned Release No. 1	No monitoring wells		
241-C Waste Line Unplanned Release No. 2	No monitoring wells		

Notes:

Source: Fecht et al. 1977.

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Table 4-12. Concentrations in 216-C-2 Reverse Well Sediments.

Element	Laboratory A	Laboratory B
Cesium-137 in $\mu\text{Ci/g}$	0.10	0.098
Europium-154 in $\mu\text{Ci/g}$	0.16	
Europium-155 in $\mu\text{Ci/g}$	0.17	
Americium-241 in $\mu\text{Ci/g}$	0.18	<0.1
Strontium-90 in $\mu\text{Ci/g}$	628	280
Plutonium-239 in $\mu\text{Ci/g}$	0.052	0.062

Notes:

Sample collected Mar. 13, 1984

Lab A: Radiation Measurement Team of the Analytical Process Development Unit, Rockwell International

Lab B: Analytical Laboratories - Rockwell International

Blanks indicate no reported values.

Table 4-13. Analysis of 209-E Critical Mass Laboratory Reflector Wastewater.

Constituent	Mean Concentration	Maximum Concentration
Barium, in $\mu\text{g/L}$	3.80E+01	3.80E+01
Calcium, in $\mu\text{g/L}$	1.97E+04	2.07E+04
Chloride, in $\mu\text{g/L}$	1.06E+03	1.22E+03
Copper, in $\mu\text{g/L}$	2.90E+01	4.30E+01
Fluoride, in $\mu\text{g/L}$	1.28E+02	1.30E+02
Iron, in $\mu\text{g/L}$	1.11E+02	1.38E+02
Lead (EP Toxic), in $\mu\text{g/L}$	9.00E+00	9.00E+00
Magnesium, in $\mu\text{g/L}$	4.48E+03	4.62E+03
Manganese, in $\mu\text{g/L}$	3.07E+01	3.90E+01
Potassium, in $\mu\text{g/L}$	7.16E+02	7.31E+02
Sodium, in $\mu\text{g/L}$	2.13E+03	2.20E+03
Strontium, in $\mu\text{g/L}$	9.63E+01	9.70E+01
Sulfate, in $\mu\text{g/L}$	1.04E+04	1.06E+04
Uranium, in $\mu\text{g/L}$	6.03E-01	7.47E-01
Zinc, in $\mu\text{g/L}$	1.76E+02	2.08E+02
Total alpha, in pCi/L	7.88E-01	9.83E-01
Total beta, in pCi/L	1.81E+00	3.03E+00

Table 4-14. Potential for Migration of Liquid Discharges to the Unconfined Aquifer.

Liquid Discharge Source	Range of Soil Column Pore Volumes in m ³⁽²⁾	Liquid Effluent Volume Received in m ³	Potential Migration to Unconfined Aquifer
Cribs and Drains			
216-C-1 Crib	260 to 785	23,400	Yes
216-C-3 Crib	404 to 1,211	5,000	Yes
216-C-4 Crib	161 to 484	170	Yes ⁽¹⁾
216-C-5 Crib	161 to 484	38	No
216-C-6 Crib	161 to 484	530	Yes ⁽¹⁾
216-C-7 Crib	323 to 967	60	No
216-C-10 Crib	129 to 387	897	Yes
Ponds, Ditches, and Trenches			
216-C-9 Pond	64,500 to 193,700	1,030,000	Yes
200 East Powerhouse Ditch	40,000 to 120,000	⁽³⁾	— —
Reverse Well			
216-C-2 Reverse Well	78 to 235	⁽³⁾	— —

Assumptions:

- Area for infiltration equal to the dimension of the base of crib/ditch/pond/reverse well
 - No evapotranspiration
 - No lateral flow assumed
 - Decision regarding the potential for migration to the unconfined aquifer is based on a pore volume of 0.1.
- (1) The pore volume of the soil column is roughly the same order of magnitude as the total known volume of the waste received. Given the high permeability of the soil column, it is possible that the discharge waste volume reached the groundwater.
- (2) Pore volume calculation: (waste unit section area) x (nominal depth to groundwater) x (porosity). Pore volume based on nominal depth to groundwater of 87m (285 ft) for all waste unit structures, except 216-C-2 Reverse Well where 75m (245 ft) was used for depth to groundwater from bottom of reverse well. Lower pore volume value reflects 0.10 porosity, higher pore volume reflects 0.30 porosity. Pore volume calculation does not account for the ability of the soil to retain the liquid discharged.
- (3) Volume information was not located.

Table 4-15 Chemical Analysis of Solids Samples from Tank 241-CX-70.

Analyte	Sample ID Numbers			
	913-5	913-4	913-3	913.3 ¹
pH	11.4	11.4	11.3	11.3
Cyanide, in mg/kg	<0.5	<0.5	<0.5	<0.5
Aluminum, in mg/kg	72,000	57,000	60,000	55,000
Calcium, in mg/kg	1,600	1,500	2,100	1,800
Chromium, in mg/kg	5,400	4,600	5,100	5,000
Iron, in mg/kg	3,200	2,800	2,900	2,700
Mercury, in mg/kg	<0.0004	<0.0005	<0.0005	<0.0005
Potassium, in mg/kg	320	240	240	250
Magnesium, in mg/kg	150	10	180	100
Manganese, in mg/kg	2,400	1,700	1,900	1,600
Sodium, in mg/kg	62,000	59,000	58,000	59,000
Nickel, in mg/kg	120	96	110	93
Selenium, in mg/kg ²	500	390	460	450
Selenium, in mg/kg ³	<0.005	<0.005	<0.005	<0.005
Uranium, in mg/kg	18,000	17,000	17,000	19,000
Zinc, in mg/kg	70	49	100	60
Total alpha, in mCi/kg	0.46	0.35	<0.4	0.44
Total beta, in mCi/kg	96	75	88	84
Cesium-137, in mCi/kg	1.2	1.3	1.2	1.2
Strontium-90, in mCi/kg	30	24	25	26
Americium-241, in mCi/kg	0.13	0.40	0.14	0.18
Plutonium 239/240, in mCi/kg	<0.6	<0.7	<0.8	<0.8

Notes: Sampling date: September 13, 1991.

¹ Duplicate analysis of sample 913-3² Analysis by Inductively Coupled Plasma Spectroscopy³ Analysis by Hydride Atomic Absorption Spectroscopy

< Not detected above detection limit indicated.

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Table 4-16. Chemical Analysis of Solids Sample from Tank 241-CX-71 (Sheet 1 of 2)

Analyte	Concentration
Aluminum, in mg/kg	2,897
Arsenic, in mg/kg	152
Barium, in mg/kg	228
Cadmium, in mg/kg	35.2
Chloride, in mg/kg	388
Chromium, in mg/kg	2,822
Chromium (VI), in mg/kg	<0.024
Copper, in mg/kg	195
Cyanide, in mg/kg	21.5
Fluoride, in mg/kg	158
Iron, in mg/kg	116,500
Lead, in mg/kg	16,020
Magnesium, in mg/kg	4,258
Manganese, in mg/kg	1,010
Mercury, in mg/kg	148
Neodymium, in mg/kg	3,196
Nickel, in mg/kg	135
Nitrate, in mg/kg	106,000
Nitrite, in mg/kg	<720
Phosphate, in mg/kg	<720
Phosphorus, in mg/kg	31,860
Selenium, in mg/kg	<1.55
Silicon, in mg/kg	2,489
Sodium, in mg/kg	1,867

Table 4-16. Chemical Analysis of Solids Sample from Tank 241-CX-71 (Sheet 2 of 2)

Analyte	Concentration
Strontium, in mg/kg	382
Sulfate, in mg/kg	668
Tin, in mg/kg	102
Titanium, in mg/kg	203
Zinc, in mg/kg	512
Total alpha, in mCi/kg	0.032
Total beta, in mCi/kg	2.45
Cesium-137, in mCi/kg	0.045
Plutonium 239/240, in mCi/kg	0.021
Strontium-90, in mCi/kg	0.63
Uranium (total), in mCi/kg	0.0013

Notes: Sampling date: October 25, 1990
 < Not detected above detection limit indicated.

Table 4-17. Candidate Chemicals of Potential Concern for the Semi-Works Aggregate Area^a. (Sheet 1 of 2)

TRANSURANICS	Radon-222	Fluoride
Americium-241	Ruthenium-106	Hydrazine
Plutonium-238	Strontium-90	Hydrogen peroxide
Plutonium-239	Tantalum-182*	Iron hydroxide
Plutonium-240	Technetium-99	Lead nitrate
Plutonium-241	Thallium-207	Manganese oxide
	Thallium-209	Nickel nitrate
	Thorium-227	Nitrate/nitrite
URANIUM	Thorium-229	Nitric acid
Uranium-233	Thorium-230	Nitric ferrous ammonium sulfate
Uranium-234	Thorium-231	Permanganate caustic
Uranium-235	Thorium-234	Phosphoric acid
Uranium-238	Tritium	Potassium
	Yttrium-90	Potassium bicarbonate
	Zirconium-95*	Potassium persulfate
FISSION PRODUCTS		Silica
Actinium-225	METALS	Silver nitrate
Actinium-227	Aluminum	Sodium
Astatine-217*	Barium	Sodium aluminate
Barium-137m	Beryllium	Sodium carbonate
Beryllium	Bismuth	Sodium dichromate
Bismuth-210	Cadmium	Sodium fluoride
Bismuth-211	Chromium	Sodium hexametaphosphate
Bismuth-213	Copper	Sodium hydroxide
Bismuth-214	Gadolinium	Sodium nitrate
Cerium-141*	Iron	Sodium nitrite
Cerium-144*	Lead	Sodium persulfate
Cesium-134	Magnesium	Sodium phosphate
Cesium-137	Manganese	Sodium silicate
Cobalt-58*	Molybdenum	Sodium sulfate
Cobalt-60	Neodymium	Sodium sulfide
Europium-152	Nickel	Sulfamic acid
Europium-154	Palladium	Sulfate
Europium-155	Strontium	Sulfuric acid
Francium-221	Silver	Trisodium phosphate
Iodine-129	Titanium	Zirconium oxide
Lead-209	Zinc	
Lead-210		VOLATILE ORGANICS
Lead-211	OTHER	Chloroform
Lead-214	INORGANICS	Hexone (MIBK)
Manganese-54*	Aluminum nitrate nonahydrate	Tributyl phosphate
Niobium-91	Aluminum sulfate	
Niobium-95*	Ammonia	
Polonium-210	Ammonium bicarbonate	
Polonium-213*	Ammonium fluoride	
Polonium-214	Ammonium nitrate	
Polonium-215*	Boron	
Polonium-218	Calcium nitrate	
Potassium-40	Carbonate	
Promethium-147	Chloride	
Protactinium-231	Chromium nitrate	
Protactinium-234m*	Ferric nitrate	
Radium-223	Ferric sulfate	
Radium-225		

Table 4-17. Candidate Chemicals of Potential Concern for the
Semi-Works Aggregate Area^a. (Sheet 2 of 2)

SEMIVOLATILE
ORGANICS

Acetic acid
1-Butanol
Caustic tartrate (CT)
Citric acid
Di-2-ethylhexyl-phosphoric acid
Ethylenediamine tetraacetic acid
(EDTA)
Glycolic acid
Kerosene
Nitrilotriacetic acid (NTA)
Nonylphenoxy polyethoxy ethanol
Normal paraffins
Oxalic acid
Pentasodium diethylene
Sodium acetate
Tartaric acid
Tetrasodium-EDTA
Triamine penta acetate (DTPA)
Trisodium hydroxyethyl-
ethylenediamine triacetate (HEDTA)

- * Candidate chemicals of concern are those that were reported in waste management unit inventories, detected at elevated levels in environmental media within the aggregate area, or are expected to occur based on historical association with waste processes.
- * The radionuclide has a half-life of <1 year and, if it is a daughter product, the parent has a half-life of <1 year, or the buildup of the short-lived daughter would result in an activity of <1% of the parent radionuclide's initial activity.

Table 4-18. Summary of Known and Suspected Contamination Released from Each Waste Management Unit and Unplanned Release at the Semi-Works Aggregate Area. (Sheet 1 of 3)

Waste Management Unit	TRU	Fission Products	Uranium	Metals	Other Inorganics	Volatiles	Semi-volatiles
Plants, Buildings, and Storage Areas							
201-C Process Building	S	S					
291-C Ventilation System							
Tanks and Vaults							
241-CX-70 Storage Tank							
241-CX-71 Storage Tank	S	S					
241-CX-72 Storage Tank							
Cris and Drains							
216-C-1 Crib	K	K	K	S	K	S	S
216-C-3 Crib	K	S	K	S	K	S	S
216-C-4 Crib	S	S	S	S	S		S
216-C-5 Crib	K	S	K	S	K	S	S
216-C-6 Crib	K	S	K	S	K	S	S
216-C-7 Crib				K	K	S	S
216-C-10 Crib	K	S	K	S	S	S	S
Critical Mass Laboratory Dry Well North							
Critical Mass Laboratory Dry Well South							

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Table 4-18. Summary of Known and Suspected Contamination Released from Each Waste Management Unit and Unplanned Release at the Semi-Works Aggregate Area. (Sheet 2 of 3)

Waste Management Unit	TRU	Fission Products	Uranium	Metals	Other Inorganics	Volatiles	Semi-volatiles
Critical Mass Laboratory Dry Well East							
Gatehouse French Drain (1)		S					
Reverse Wells							
216-C-2 Reverse Well	K	K	K	S	S		S
Ponds, Ditches, and Trenches							
216-C-9 Pond	K	S	K	S	S	S	S
200 East Powerhouse Ditch				K	K		K
Septic Tanks and Associated Drain Fields							
2607-E-5 Septic Tank and Drain Field							
2607-E-7A Septic Tank and Drain Field							
Transfer Facilities, Diversion Boxes, and Pipelines							
Semi-Works Valve Pit							
Critical Mass Laboratory Valve Pit (2)							
241-C-154 Diversion Box							
Burial Sites							
218-C-9 Burial Ground		S	S	K	S		
Unplanned Releases							
UN-200-E-36	S	S		S	S		
UN-200-E-37	S	S		S	S		

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Table 4-18. Summary of Known and Suspected Contamination Released from Each Waste Management Unit and Unplanned Release at the Semi-Works Aggregate Area. (Sheet 3 of 3)

Waste Management Unit	TRU	Fission Products	Uranium	Metals	Other Inorganics	Volatiles	Semi-volatiles
UN-200-E-98		S					
UN-200-E-141			S		S		
241-C Waste Line Unplanned Release No. 1		S		S	S		
241-C Waste Line Unplanned Release No. 2		S		S	S		

Notes:

- K Contamination of environmental media is known to have occurred based on waste inventory or sampling data and knowledge of waste release mechanism.
- S Contamination of environmental media is suspected to have occurred based on historical process information or indications from nonspecific sampling data (e.g., gamma logs).

(1) Unit is marked radioactive but no inventory information available in documents reviewed.

(2) No inventory information available in documents reviewed.

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Table 4-19. Chemicals of Potential Concern for the Semi-Works Aggregate Area.

TRANSURANICS		
Americium-241	Thorium-227	Nickel nitrate
Plutonium-238	Thorium-229	Nitrate/nitrite
Plutonium-239	Thorium-230	Nitric acid
Plutonium-240	Thorium-231	Nitric ferrous ammonium sulfate
Plutonium-241	Thorium-234	Permanganate caustic
	Tritium	Silver nitrate
	Yttrium-90	Sodium dichromate
URANIUM		
Uranium-233		Sodium fluoride
Uranium-234		Sodium nitrate
Uranium-235		Sodium nitrite
Uranium-238		
FISSION PRODUCTS		
Actinium-225	METALS	
Actinium-227	Barium	VOLATILE ORGANICS
Barium-137m	Beryllium	Chloroform
Bismuth-210	Bismuth	Hexone (MIBK)
Bismuth-211	Cadmium	
Bismuth-213	Chromium	
Bismuth-214	Copper	SEMIVOLATILE ORGANICS
Cesium-134	Iron	1-Butanol
Cesium-137	Lead	Tributyl phosphate
Cobalt-60	Manganese	
Europium-152	Molybdenum	
Europium-154	Nickel	
Europium-155	Palladium	
Francium-221	Silver	
Iodine-129	Zinc	
Lead-209	OTHER	
Lead-210	INORGANICS	
Lead-211	Ammonia	
Lead-214	Ammonium bicarbonate	
Niobium-91	Boron	
Polonium-214	Calcium nitrate	
Polonium-218	Chromium nitrate	
Potassium-40	Ferric hydroxide	
Protactinium-231	Ferric nitrate	
Radium-225	Ferric sulfate	
Radium-226	Ferrous sulfamate	
Ruthenium-106	Fluoride	
Strontium-90	Hydrazine	
Technetium-99	Lead nitrate	
Thallium-207		

Table 4-20. Soil-Water Distribution Coefficients (K_d) for Radionuclides^a and Inorganics of Potential Concern for the Semi-Works Aggregate Area. (Sheet 1 of 2)

Element or Chemical	Recommended K_d for Hanford Site (Serne and Wood 1990) in ml/g	Conservative Default K_d^b (Serne and Wood 1990) in ml/g	MEPAS Default K_d pH 6-9 ^c (Streng and Peterson 1989) in ml/g	Mobility Class
Actinium			228	Low
Americium	100 to 1,000 (<1 at pH 1-3)	100	82	Low
Ammonia				na
Barium		50	530	Moderate
Beryllium	-	-	70	Moderate
Bismuth		20		Moderate
Cadmium		15	14.9	Moderate
Cesium	200 to 1,000 1 to 200 (acidic waste)	50	51	Low
Chromium (VI)		0	16.8	Moderate-High
Cobalt	500 to 2,000	10	1.9	Low
Copper		15	41.9	Moderate
Europium		50	228	Moderate
Fluoride			0	High
Francium				na
Iodine	<1	0	0	High
Lead		30	234	Moderate
Manganese		20	16.5	Moderate
Molybdenum		0	40	Low
Nickel		15	12.2	Moderate
Niobium			50	Moderate
Nitrate/nitric acid			0	High
Palladium			0.4	High
Plutonium	100 to 1,000 < 1 at pH 1 to 3	100	10	Low
Polonium			5.9	Moderate
Potassium			0	High
Protactinium			0	High

Table 4-20. Soil-Water Distribution Coefficients (K_d) for Radionuclides^a and Inorganics of Potential Concern for the Semi-Works Aggregate Area. (Sheet 2 of 2)

Element or Chemical	Recommended K_d for Hanford Site (Serne and Wood 1990) in ml/g	Conservative Default K_d^b (Serne and Wood 1990) in ml/g	MEPAS Default K_d pH 6-9 ^c (Streng and Peterson 1989) in ml/g	Mobility Class
Radium		20	24.3	Moderate
Ruthenium	20 to 700 (<2 at >1 M nitrate)		274	Moderate
Silver		20	0.4	Moderate
Strontium	5 to 100 3 to 5 (acidic conditions) 200 to 500 (w/phosphate or oxalate)	10	24.3	Moderate
Technetium	0 to 1	0	3	High
Thorium		50	100	Moderate
Tritium	0	0	0	High
Uranium		0	0	High
Yttrium			278	Low
Zinc		15	12.7	Moderate

^a Radionuclides with half-lives of greater than one year or short-lived products of long-lived precursors.

^b Average K_d s for low salt and organic solutions with neutral pH.

^c Default values for pH 6-9 and soil content of [clay + organic matter + metal oxyhydroxides] $< 10\%$ (Streng and Peterson 1989).

Value was not provided for this element in this reference.

na K_d value was not provided in sources cited in this table.

Table 4-21. Mobility of Inorganic Species in Soil.

High mobility ($K_d < 5$)	
Boron	Protactinium
Fluoride	Technetium
Iodine	Tritium
Molybdenum	Uranium
Nitrate/Nitrite	
Palladium	
Potassium	
Moderate mobility ($5 < K_d < 100$)	
Barium	Nickel
Beryllium	Niobium
Bismuth	Polonium
Cadmium	Radium
Cerium	Ruthenium
Chromium(VI)	Silver
Copper	Strontium
Europium	Thorium
Lead	Zinc
Manganese	
Low Mobility ($K_d > 100$)	
Actinium	
Americium	
Cesium	
Molybdenum	
Plutonium	
Yttrium	

Table 4-22. Physical/Chemical Properties of Organic Compounds of Potential Concern at Semi-Works Aggregate Area.

Compound	Molecular Weight in g/mole	Water Solubility in mg/liter	Vapor Pressure in mm Hg	Henry's Law Constant (K_h) in atm-m ³ /mo	Soil/Organic Matter Partition Coef. (K_{oc}) in ml/g
1-Butanol	74.12	79,000	24	4.8×10^{-6}	4.7
Chloroform (trichloromethane)	119	8,200	150	2.9×10^{-3}	31
Hexone (MIBK)	100.16	19,000	6	4.2×10^{-5}	19
Tributyl phosphate	266.3	280	15	1.9×10^{-2}	6,000

Sources: Streng and Peterson 1989, except as noted in footnotes below.

- ^a Values listed in Hazardous Substance Data Base (HSDB), National Library of Medicine database (HSDB 1991).
- ^b Kerosene properties are represented by 2-methyl naphthalene.

Blank - Value not available from above sources.

Table 4-23. Radiological Properties of Candidate Radionuclides of Potential Concern for the Semi-Works Aggregate Area (Sheet 1 of 2).

Radionuclide	Half-Life	Specific Activity ^a in Ci/g	Radiation of Concern ^b
²²⁵ Ac	10 d	5.8×10^4	α
²²⁷ Ac	21.8 yr	7.2×10^1	β, α
²⁴¹ Am	432 yr	3.4×10^0	α
²¹⁷ At	0.032 sec	1.6×10^{12}	α
^{137m} Ba	2.6 min	5.3×10^8	γ
²¹⁰ Bi	5.01 d	1.2×10^5	β
²¹¹ Bi	2.13 min	4.2×10^8	α, β
²¹³ Bi	45.6 min	1.9×10^7	β, α
²¹⁴ Bi	19.9 min	4.4×10^7	β, γ
¹⁴¹ Ce	32.5 d	2.8×10^4	β, γ^c
¹⁴⁴ Ce	284.3 d	3.2×10^3	β, γ^c
⁵⁸ Co	70.8 d	3.2×10^4	γ^c
⁶⁰ Co	5.3 yr	1.1×10^3	γ
¹³⁴ Cs	2.06 yr	1.3×10^3	γ
¹³⁷ Cs	30 yr	8.7×10^1	γ^c
¹⁵² Eu	13.6 yr	1.7×10^2	β, γ^c
¹⁵⁴ Eu	8.8 yr	2.7×10^2	β, γ^c
¹⁵⁵ Eu	4.96 yr	4.6×10^2	β, γ^c
²²¹ Fr	4.8 min	1.8×10^8	α
³ H	12.3 yr	9.7×10^3	β
¹²⁹ I	1.6×10^7 yr	1.7×10^{-4}	β
⁴⁰ K	1.3×10^9 yr	6.7×10^{-6}	β, γ^c
⁵⁴ Mn	312.7 d	7.7×10^3	γ^c, e^-
⁹¹ Nb	10,000 yr	3.9×10^{-1}	γ^c
⁹⁵ Nb	34.97 d	3.9×10^4	β, γ
²³¹ Pa	32,800 yr	4.7×10^{-2}	α
^{234m} Pa	1.17 min	6.9×10^8	β
²⁰⁹ Pb	3.25 hr	4.5×10^6	β
²¹⁰ Pb	22.3 yr	7.6×10^1	β
²¹¹ Pb	36.1 min	2.5×10^7	β
²¹⁴ Pb	26.8 min	3.3×10^7	β, γ^c
¹⁴⁷ Pm	2.6 yr	9.3×10^2	β
²¹⁰ Po	128 d	4.9×10^3	α
²¹³ Po	4.2×10^{-6} sec	1.3×10^{16}	α

Table 4-23. Radiological Properties of Candidate Radionuclides of Potential Concern for the Semi-Works Aggregate Area (Sheet 2 of 2).

Radionuclide	Half-Life	Specific Activity ^a in Ci/g	Radiation of Concern ^b
²¹⁴ Po	6 x 10 ⁻⁵ sec	8.8 x 10 ¹⁴	α
²¹⁵ Po	7.8 x 10 ⁻⁴ sec	2.9 x 10 ¹³	α
²¹⁸ Po	3.05 min	2.8 x 10 ⁸	α
²³⁸ Pu	87.7 yr	1.7 x 10 ¹	α
²³⁹ Pu	24,400 yr	6.2 x 10 ⁻²	α
²⁴⁰ Pu	6,560 yr	2.3 x 10 ⁻¹	α
²⁴¹ Pu	14.4 yr	1.0 x 10 ²	β
²²³ Ra	11.43 d	5.1 x 10 ⁴	α
²²⁵ Ra	14.8 d	3.9 x 10 ⁴	β
²²⁶ Ra	1,600 yr	9.9 x 10 ⁻¹	α
²¹⁹ Rn	4.0 sec	1.3 x 10 ¹⁰	α
²²² Rn	3.8 d	1.5 x 10 ⁵	α, γ
¹⁰⁶ Ru	1.0 yr	3.4 x 10 ³	β, γ ^c
⁹⁰ Sr	28.5 yr	1.4 x 10 ²	β
¹⁸² Ta	114.7 d	3.4 x 10 ⁻⁷	β, γ ^c
⁹⁹ Tc	213,000 yr	1.7 x 10 ⁻²	β
²²⁷ Th	18.7 d	3.1 x 10 ⁴	α
²²⁹ Th	7,340 yr	2.1 x 10 ⁻¹	α
²³⁰ Th	77,000 yr	2.1 x 10 ⁻²	α
²³¹ Th	25.5 hr	5.3 x 10 ⁵	β
²³⁴ Th	24.1 d	2.3 x 10 ⁻⁴	β
²⁰⁷ Tl	4.77 min	1.9 x 10 ⁸	β, γ
²⁰⁹ Tl	2.2 min	4.1 x 10 ⁸	γ
²³³ U	159,000 yr	9.7 x 10 ⁻³	α
²³⁴ U	244,500 yr	6.2 x 10 ⁻³	α
²³⁵ U	7.0 x 10 ⁸ yr	2.2 x 10 ⁻⁶	α, γ
²³⁸ U	4.5 x 10 ⁹ yr	3.4 x 10 ⁻⁷	α
⁹⁰ Y	6.41 hr	5.4 x 10 ⁵	β
⁹⁵ Zr	64 d	2.1 x 10 ⁴	β

^a Source: DOE 1990.

^b α - alpha decay; β - negative beta decay; γ - release of gamma rays.

^c Gamma radiation due to daughter product.

Table 4-24. Relative Risks for Radionuclides of Potential Concern for the Semi-Works Aggregate Area. (Sheet 1 of 2)

Radionuclide	Half-Life ^a	Air Unit Risk ^b in (pCi/m ³) ⁻¹	Drinking Water Unit Risk ^c in (pCi/L) ⁻¹	Soil Ingestion Unit Risk ^d in (pCi/g) ⁻¹	External Exposure Unit Risk ^e in (pCi/g) ⁻¹
²²⁵ Ac	10 d	1.2 x 10 ⁻³	8.7 x 10 ⁻⁷	4.6 x 10 ⁻⁸	9.4 x 10 ⁻⁶
²²⁷ Ac	21.8 yr	4.2 x 10 ⁻²	1.8 x 10 ⁻⁵	9.5 x 10 ⁻⁷	1.3 x 10 ⁻⁷
²⁴¹ Am	433 yr	2.1 x 10 ⁻²	1.6 x 10 ⁻⁵	8.4 x 10 ⁻⁷	1.6 x 10 ⁻⁵
^{137m} Ba	2.6 min	3 x 10 ⁻¹⁰	1.2 x 10 ⁻¹⁰	6.5 x 10 ⁻¹²	3.4 x 10 ⁻⁴
²¹⁰ Bi	5.01 d	4.1 x 10 ⁻⁵	9.7 x 10 ⁻⁸	5.1 x 10 ⁻⁹	0
²¹¹ Bi	2.13 min	9.7 x 10 ⁻⁸	6.1 x 10 ⁻¹⁰	3.2 x 10 ⁻¹¹	2.8 x 10 ⁻⁵
²¹³ Bi	45.6 min	1.6 x 10 ⁻⁷	1.2 x 10 ⁻⁸	6.2 x 10 ⁻¹⁰	8.1 x 10 ⁻⁵
²¹⁴ Bi	19.9 min	1.1 x 10 ⁻⁶	7.2 x 10 ⁻⁹	3.8 x 10 ⁻¹⁰	8.0 x 10 ⁻⁴
⁶⁰ Co	5.3 yr	8.1 x 10 ⁻⁵	7.8 x 10 ⁻⁷	4.1 x 10 ⁻⁸	1.3 x 10 ⁻³
¹³⁴ Cs	2.06 yr	1.4 x 10 ⁻⁵	2.1 x 10 ⁻⁶	1.1 x 10 ⁻⁷	8.9 x 10 ⁻⁴
¹³⁷ Cs	30 yr	9.6 x 10 ⁻⁶	1.4 x 10 ⁻⁶	7.6 x 10 ⁻⁸	0
¹⁵² Eu	13.3 yr	6.1 x 10 ⁻³	1.1 x 10 ⁻⁷	5.7 x 10 ⁻⁹	6.3 x 10 ⁻⁴
¹⁵⁴ Eu	8.8 yr	7.2 x 10 ⁻⁵	1.5 x 10 ⁻⁷	8.1 x 10 ⁻⁹	6.8 x 10 ⁻⁴
¹⁵⁵ Eu	4.96 yr	na	na	na	
²²¹ Fr	4.8 min	4.7 x 10 ⁻⁷	3.0 x 10 ⁻⁹	1.6 x 10 ⁻¹⁰	1.9 x 10 ⁻⁵
³ H	12.3 yr	4.0 x 10 ⁻⁸	2.8 x 10 ⁻⁹	1.5 x 10 ⁻¹⁰	0
⁴⁰ K	1.3 x 10 ⁹ yr	4.0 x 10 ⁻⁶	5.7 x 10 ⁻⁷	3.0 x 10 ⁻⁸	7.8 x 10 ⁻⁵
⁹¹ Nb	10,000 yr	na	na	na	na
²³¹ Pa	32,800 yr	2.0 x 10 ⁻²	9.7 x 10 ⁻⁶	5.1 x 10 ⁻⁷	2.0 x 10 ⁻⁵
²⁰⁹ Pb	3.25 hr	3.6 x 10 ⁻⁸	4.3 x 10 ⁻⁹	2.3 x 10 ⁻¹⁰	0
²¹⁰ Pb	22.3 yr	8.7 x 10 ⁻⁴	3.4 x 10 ⁻⁵	1.8 x 10 ⁻⁶	1.8 x 10 ⁻⁶
²¹¹ Pb	36.1 min	1.5 x 10 ⁻⁶	9.2 x 10 ⁻⁹	4.9 x 10 ⁻¹⁰	2.9 x 10 ⁻⁵
²¹⁴ Pb	26.8 min	1.5 x 10 ⁻⁶	9.2 x 10 ⁻⁹	4.9 x 10 ⁻¹⁰	1.5 x 10 ⁻⁴
²¹⁴ Po	6 x 10 ⁻⁵ sec	1.4 x 10 ⁻¹³	5.1 x 10 ⁻¹⁶	2.7 x 10 ⁻¹⁷	4.7 x 10 ⁻⁸
²¹⁸ Po	3.05 min	3.0 x 10 ⁻⁷	1.4 x 10 ⁻⁹	7.6 x 10 ⁻¹¹	0
²³⁸ Pu	87.7 yr	2.1 x 10 ⁻²	1.4 x 10 ⁻⁵	7.6 x 10 ⁻⁷	5.9 x 10 ⁻⁷
²³⁹ Pu	24,400 yr	2.6 x 10 ⁻²	1.6 x 10 ⁻⁵	8.4 x 10 ⁻⁸	2.6 x 10 ⁻⁷
²³⁹ Pu oxide	24,400 yr	2.6 x 10 ⁻²	1.6 x 10 ⁻⁶	8.4 x 10 ⁻⁸	2.6 x 10 ⁻⁷

Table 4-24. Relative Risks for Radionuclides of Potential Concern for the Semi-Works Aggregate Area. (Sheet 2 of 2)

Radionuclide	Half-Life ^a	Air Unit Risk ^b in (pCi/m ³) ⁻¹	Drinking Water Unit Risk ^c in (pCi/L) ⁻¹	Soil Ingestion Unit Risk ^d in (pCi/g) ⁻¹	External Exposure Unit Risk ^e in (pCi/g) ⁻¹
²⁴⁰ Pu	6,560 yr	2.1 x 10 ⁻²	1.6 x 10 ⁻⁵	8.4 x 10 ⁻⁸	5.9 x 10 ⁻⁷
²⁴⁰ Pu oxide	6,560 yr	2.1 x 10 ⁻²	1.6 x 10 ⁻⁶	8.4 x 10 ⁻⁸	5.9 x 10 ⁻⁷
²⁴¹ Pu	14.4 yr	1.5 x 10 ⁻⁴	2.5 x 10 ⁻⁷	1.3 x 10 ⁻⁸	0
²²⁵ Ra	14.8 d	8.2 x 10 ⁻⁴	3.4 x 10 ⁻⁶	1.8 x 10 ⁻⁷	8.0 x 10 ⁻⁶
²²⁶ Ra	1,600 yr	1.5 x 10 ⁻³	6.1 x 10 ⁻⁶	3.2 x 10 ⁻⁷	4.1 x 10 ⁻⁶
¹⁰⁶ Ru	1.0 yr	2.3 x 10 ⁻⁴	4.9 x 10 ⁻⁷	2.6 x 10 ⁻⁸	0
⁹⁰ Sr	28.5 yr	2.8 x 10 ⁻⁵	1.7 x 10 ⁻⁶	8.9 x 10 ⁻⁸	0
⁹⁹ Tc	213,000 yr	4.2 x 10 ⁻⁶	6.6 x 10 ⁻⁸	3.5 x 10 ⁻⁹	3.4 x 10 ⁻¹⁰
²²⁷ Th	18.72 d	2.5 x 10 ⁻³	2.5 x 10 ⁻⁷	1.3 x 10 ⁻⁸	6.6 x 10 ⁻⁶
²²⁹ Th	7,340 yr	3.9 x 10 ⁻²	2.0 x 10 ⁻⁶	1.1 x 10 ⁻⁷	5.8 x 10 ⁻⁵
²³⁰ Th	77,000 yr	1.6 x 10 ⁻²	1.2 x 10 ⁻⁶	6.5 x 10 ⁻⁸	5.9 x 10 ⁻⁷
²³¹ Th	25.5 hr	2.5 x 10 ⁻⁷	2.0 x 10 ⁻⁸	1.1 x 10 ⁻⁹	1.1 x 10 ⁻⁵
²³⁴ Th	24.1 d	1.6 x 10 ⁻⁵	2.0 x 10 ⁻⁷	1.1 x 10 ⁻⁸	5.6 x 10 ⁻⁶
²⁰⁷ Tl	4.77 min	2.3 x 10 ⁻⁹	6.6 x 10 ⁻¹⁰	3.5 x 10 ⁻¹¹	1.2 x 10 ⁻⁶
²⁰⁹ Tl	2.20 min	2.2 x 10 ⁻⁹	7.2 x 10 ⁻¹⁰	3.8 x 10 ⁻¹¹	1.1 x 10 ⁻³
²³³ U	159,000 yr	1.4 x 10 ⁻²	7.2 x 10 ⁻⁶	3.8 x 10 ⁻⁷	3.2 x 10 ⁻⁷
²³⁴ U	244,500 yr	1.4 x 10 ⁻²	7.2 x 10 ⁻⁶	3.8 x 10 ⁻⁷	5.6 x 10 ⁻⁷
²³⁵ U	7.0 x 10 ⁸ yr	1.3 x 10 ⁻²	6.6 x 10 ⁻⁶	3.5 x 10 ⁻⁷	9.7 x 10 ⁻⁵
²³⁸ U	4.5 x 10 ⁹ yr	1.2 x 10 ⁻²	6.6 x 10 ⁻⁶	3.5 x 10 ⁻⁷	4.5 x 10 ⁻⁷
⁹⁰ Y	64.1 hr	2.8 x 10 ⁻⁶	1.6 x 10 ⁻⁷	8.6 x 10 ⁻⁹	0

^a Source: DOE 1990^b Excess cancer risk associated with lifetime exposure to 1 pCi/m³ (10⁻¹² curies) per day in air (EPA 1991).^c Excess cancer risk associated with lifetime exposure to 1 pCi (10⁻¹² curies) per day in drinking water (EPA 1991).^d Excess cancer risk associated with lifetime exposure to 1 pCi/g (10⁻¹² curies/g) per day in soil (EPA 1991).^e Excess cancer risk associated with lifetime exposure to surface soils containing 1 pCi/g of gamma-emitting radionuclides (EPA 1991).

na No information available.

Table 4-25. Potential Chronic Health Effects of Candidate Chemicals of Potential Concern for the Semi-Works Aggregate Area. (Sheet 1 of 3)

Chemical	Tumor Site Inhalation Route; Oral Route [Weight of Evidence Group ^a]	Non-carcinogenic Chronic Health Effects Inhalation Route; Oral Route
INORGANIC CHEMICALS		
Aluminum		
Aluminum nitrate nonahydrate	(see nitrate)	(see nitrate)
Aluminum sulfate		
Ammonia		decreased pulmonary function; degrades odor; taste of water
Ammonium bicarbonate	(see ammonia)	(see ammonia)
Ammonium fluoride	(see fluoride, ammonia)	(see fluoride, ammonia)
Ammonium nitrate	(see ammonia, nitrate)	(see ammonia, nitrate)
Barium		fetotoxicity; increased blood pressure
Beryllium	lung [B2]; tatal tumors [B2]	
Bismuth	NA;NA	NA;NA
Boron		NA; testicular lesions
Cadmium	respiratory tract [B1]; NA	cancer; renal damage
Calcium nitrate	(see nitrate)	(see nitrate)
Chloride		
Chromium	lung [A] - Cr(VI) only; NA	nasal mucosa atrophy (Cr(III)and (VI)); hepatotoxicity (Cr (III)
Chromium nitrate	(see chromium and nitrate)	(see chromium and nitrate)
Copper		NA; gastrointestinal irritation
Ferric nitrate	(see nitrate)	(see nitrate)
Ferric hydroxide		
Ferric sulfate		
Ferrous sulfamate		
Fluoride		NA; dental fluorosis at high levels
Hydrazine	nasal cavity [B2];liver[B2]	NA;NA
Hydrogen peroxide	NA;NA	NA;NA
Iron		
Lead	[B2] ^b ; [B2]	central nervous system (CNS) effects ^b ; CNS effects
Lead nitrate	(see lead, nitrate)	(see lead, nitrate)
Magnesium		
Manganese		respiratory, psychomotor symptoms; no effect
Molybdenum		NA;changes in biochemical indices
Neodymium		
Nickel	respiratory tract [A]; NA	cancer; reduced weight gain

Table 4-25. Potential Chronic Health Effects of Candidate Chemicals of Potential Concern for the Semi-Works Aggregate Area. (Sheet 2 of 3)

Chemical	Tumor Site Inhalation Route; Oral Route [Weight of Evidence Group ^a]	Non-carcinogenic Chronic Health Effects Inhalation Route; Oral Route
Nickel nitrate	(see nickel, nitrate)	(see nickel, nitrate)
Nitrate/Nitrite		NA; methemoglobinemia in infants ^c
Nitric acid	(see nitrate)	(see nitrate)
Nitric ferrous ammonium sulfate	(see nitrate, ammonia)	(see nitrate, ammonia)
Palladium		
Permanganate caustic	(see manganese)	(see manganese)
Phosphate		
Phosphoric acid		
Potassium		
Potassium bicarbonate		
Potassium persulfate		
Silica		
Silver		NA; argyria
Silver nitrate	(see nitrate, silver)	(see nitrate, silver)
Sodium		
Sodium aluminate -		
Sodium carbonate		
Sodium dichromate	(see chromium(VI))	(see chromium(VI))
Sodium fluoride	(see fluoride)	(see fluoride)
Sodium hexametaphosphate		
Sodium hydroxide		
Sodium nitrate	(see nitrate)	(see nitrate)
Sodium nitrite	(see nitrite)	(see nitrite)
Sodium persulfate		
Sodium phosphate		
Sodium silicate		
Sodium sulfate		
Sodium sulfide		
Strontium		
Sulfamic acid		
Sulfate		
Sulfuric acid		respiratory; NA
Titanium		
Trisodium phosphate		
Uranium		NA; body weight loss, nephrotoxicity
Zinc		NA; anemia

Table 4-25. Potential Chronic Health Effects of Candidate Chemicals of Potential Concern for the Semi-Works Aggregate Area. (Sheet 3 of 3)

Chemical	Tumor Site Inhalation Route; Oral Route [Weight of Evidence Group ^a]	Non-carcinogenic Chronic Health Effects Inhalation Route; Oral Route
Zirconium oxide		
ORGANIC CHEMICALS		
Acetic acid		
1-Butanol	NA;NA	NA; effects on erythrocytes
Caustic tartrate		
Chloroform	liver [B2]; kidney [B2]	NA; liver lesions
Citric acid		
Dibutyl phosphate		
Di-2-ethylhexyl phosphoric acid		
Ethylenediamine tetraacetic acid (EDTA)		
Glycolic acid		
Hexone (MIBK)		liver and kidney effects; liver and kidney effects
Kerosene (n-paraffins)		
Nitrilotriacetic acid (NTA)		
Nonylphenoxy polyethoxy ethanol		
Oxalic acid		
Pentasodium diethylene		
Sodium acetate		
Sodium oxalate		
Tartaric acid		
Tetrasodium-EDTA		
Triamine pentaacetate		
Tributyl phosphate		
Trisodium hydroxyethyl- EDTA		

^a Weight of Evidence Groups for carcinogens: A - Human carcinogen (sufficient evidence of carcinogenicity in humans); B - Probable Human Carcinogen (B1 - limited evidence of carcinogenicity in humans; B2 - sufficient evidence of carcinogenicity in animals with inadequate or lack of data in humans); C - Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data); D - Not Classifiable as to Human Carcinogenicity (inadequate or no evidence).

^b Lead is considered by EPA to have both neurotoxic and carcinogenic effects; however, no toxicity criteria are available for lead at the present time.

^c Toxic effect is considered to occur from exposure to nitrite; nitrate can be converted to nitrite in the body by intestinal bacteria. NA Information not available.

Source: EPA 1991 and 1992. A blank space means that no information was available from these sources.

5.0 HEALTH AND ENVIRONMENTAL CONCERNS

This preliminary qualitative evaluation of potential human health concerns is intended to provide input to the Semi-Works Aggregate Area waste management unit recommendation process (Section 9.0). This process requires consideration of immediate and long-term impacts to human health and the environment. The approach that has been taken to identify potential health concerns related to individual waste management units and unplanned releases is as follows:

- Contaminants of potential concern are identified for each exposure pathway that is likely to occur within the Semi-Works Aggregate Area. Selection of contaminants was discussed in Section 4.2. Contaminants of potential concern were selected from the list of candidate contaminants of potential concern presented in Table 4-16. This table includes contaminants that are likely to be present in the environment based on occurrence in the liquid process wastes that were discharged to soils, and also contaminants that have been detected in environmental samples within the aggregate area but have not been identified as components of Semi-Works waste streams.
- Exposure pathways potentially applicable to individual waste management units are identified based on the presence of the above contaminants of potential concern in wastes in the waste management units, consideration of known or suspected releases from those waste management units, and the physical and institutional controls affecting site access and use over the period of interest. The relationships between waste management units and exposure pathways are summarized in the conceptual model (Section 4.2).
- Estimates of relative hazard derived for the Semi-Works waste management units are identified using the CERCLA Hazard Ranking System (HRS), modified Hazard Ranking System (mHRS), surface radiation survey data, and by Westinghouse Hanford Environmental Protection Group scoring.

The human health concerns and various hazard ranking scores listed above are used to establish whether or not a site is considered a "high" priority. In the data evaluation process presented in Section 9.0, "high" priority sites are evaluated for the potential implementation of an IRM. "Low" priority sites are evaluated to determine

what type of additional investigation is necessary to establish a final remedy. Further detail is presented in Section 9.0.

The data used for this human health evaluation are presented in the earlier sections of this report. The types of data that have been assessed include site histories and physical descriptions (Section 2.0), descriptions of the physical environment of the study area (Section 3.0) and a summary of the available chemical and radiological data for each waste management unit (Section 4.0).

The quality and sufficiency of these data are assessed in Section 8.0. This information is also used to identify ARARs (Section 6.0).

5.1 CONCEPTUAL FRAMEWORK FOR RISK-BASED SCREENING

The range of potential human health exposure pathways at the Semi-Works Aggregate Area was summarized in Section 4.2. The EPA (1989a) considers a human exposure pathway to consist of four elements: 1) a source and mechanism for contaminant release, 2) a retention or transport medium (or media), 3) a point of potential human contact, and 4) an exposure route (e.g., ingestion) at the contact point. The probability of the existence of a particular pathway is dependent upon the physical and institutional controls affecting site access and use. In the absence of site access controls and other land use restrictions, the identified potential exposure pathways could all occur. For example, it could be hypothesized that an individual could establish a residence within the boundaries of the Semi-Works Aggregate Area, disrupt the soil surface and contact buried contamination, and drill a well and withdraw contaminated groundwater for drinking water and crop irrigation. However, within the 5- to 10-year period of interest associated with identification and prioritization of remedial actions within the Semi-Works Aggregate Area, unrestricted access and uncontrolled disruption of buried contaminants have a negligible probability of occurrence.

For the purpose of identifying health hazards associated with Semi-Works Aggregate Area waste management units, and prioritizing remediation actions for those units, an occupational exposure scenario was determined to be the most appropriate. While work activities are assumed to include occasional contact with surface soils, it is assumed that no contact with buried contaminants will take place without proper protective measures.

Workers may be exposed via the following routes at the Semi-Works Aggregate Area:

- Ingestion of surface soils

- Inhalation of volatilized contaminants and resuspended particles
- Direct dermal contact with surface soils
- Direct exposure to radiation from surface soils and airborne resuspended particles.

Since evaluation of migration in the saturated zone is not within the scope of a source AAMS, ingestion or contact with groundwater was not evaluated as an exposure pathway. However, since migration of waste constituents within the saturated zone will be addressed in the 200 East Groundwater AAMS, contaminants likely to migrate to the water table and waste management units that have a high potential to impact groundwater will be identified.

5.2 POTENTIAL EXPOSURE SCENARIOS AND HUMAN HEALTH CONCERNS

The routes by which a Hanford Site worker could potentially be exposed to contamination at the waste management units include ingestion, inhalation, direct contact with soils, and direct exposure to radiation. To evaluate the potential for exposure at individual waste management units, it is necessary to have data available for surface soils, air, and radiation levels. Although samples have been collected from each of these media, only the surface radiation survey data, including contamination levels and dose rate are specific to individual waste management units. Therefore, only pathways associated with the surface radiological contamination and external dose rates can be evaluated with confidence at this time. Exposures by other pathways were evaluated based on available knowledge about contaminants disposed of to the waste management unit and the engineered barriers to releases.

5.2.1 External Exposure

External dose rate surveys, which are performed on a waste management unit basis, were used as the measure of a unit's potential for impacting human health through direct external radiation exposure. The contaminants of potential concern for this pathway are the radionuclides that emit moderate to high energy penetrating gamma radiation. The measured dose rates at Semi-Works Aggregate Area waste management units are presented in Table 5-1 from the available survey data.

Recent radiation survey data (i.e., within the past 5 years) are available for 14 of the 25 Semi-Works Aggregate Area waste management units. Of the 14 units that had been surveyed, 10 were reported as having no contamination detected.

Westinghouse Hanford manual WHC-CM-4-10, Section 7 (WHC 1988b) was used as the basis for setting one of the criteria that are used to identify waste management units that can be considered high priority sites. The manual indicates that posting ("Radiation Area") and access controls are to be implemented at a level of 2 mrem/hr for the purpose of personnel protection. This criterion is set by DOE-RL and is intended to provide sufficient protectiveness to occupational workers such that exposures are below the U.S. DOE radiation protection standard of 5 rem annual effective dose equivalent. With the same objective in mind, the level of 2 mrem/hr is recommended as one of the criteria for distinguishing high priority from lower priority waste management units. None of the waste management units exceeded this criterion during recent radiation surveys performed during the past 5 years.

Elevated levels of radiation were reportedly associated with some of the unplanned releases listed in Table 5-1. However, several of these releases occurred and were surveyed more than 20 years ago and more recent survey data are not available. Some of the releases were reportedly remediated by removing contaminated soil for disposal in burial grounds, paving or covering the area with soil, or flushing the soil with water (DeFord 1992). The effectiveness of the various remediation measures is not known, and confirmatory survey measurements generally are not available. Thus, with the exception of unplanned releases located within engineered waste units which are routinely surveyed, information on the current radiological status of unplanned releases is deficient, and is identified as a data gap in Section 8.0.

5.2.2 Ingestion of Soil or Inhalation of Fugitive Dust

Radionuclides and nonradioactive chemicals of concern for the soil ingestion and fugitive dust inhalation pathways are those that are nonvolatile, persistent in surface soils, and have appreciable carcinogenic or toxic effects by ingestion or inhalation. However, little information is available to evaluate the presence of specific radionuclides or nonradioactive chemicals in surface soils. Available gross activity survey data for the Semi-Works Aggregate Area waste management units are provided in Table 5-1.

The Westinghouse Hanford Environmental Protection group policies state that the presence of any smearable alpha constitutes a potential threat to human health and qualifies a waste management unit for a high remediation priority (Huckfeldt 1991). Waste management units that exhibit elevated alpha readings in radiological surveys can be presumed to have surface contamination, since alpha radiation cannot penetrate solids. As indicated in Table 4-5, smearable alpha was detected only at the 241-CX-70 Tank. This waste management unit is currently covered by the ash barrier and thus does not pose a hazard from contact with alpha radiation.

Westinghouse Hanford manual WHC-CM-4-10 (WHC 1988b) was also used to set criteria for identifying waste management units that can be considered high remediation priority sites. The manual indicates that posting ("Surface Contamination Area") and access controls are to be implemented at a level of 100 ct/min above background beta/gamma, and/or 20 ct/min alpha, for the purpose of personnel protection. With the same objective in mind, the levels of 100 ct/min above background beta/gamma and 20 ct/min alpha are recommended as two of the criteria for identification of high priority waste management units. For those survey readings that are in units of dis/min, a conversion will be made to ct/min assuming a detector efficiency of 10%.

Waste management units that exceed the above criterion are the 241-CX-70 Storage Tank, the 241-CX-72 Storage Tank, and the 216-C-2 Reverse Well (see Table 5-1). The radiation measured at the tanks and reverse well was confined to discrete areas—bricks and concrete in the ash barrier material (storage tanks) and accessory piping (reverse well).

It should be noted that these radiation readings may indicate transient conditions such as the presence of contaminated vegetation and that routine stabilization of surface contamination is carried out under the auspices of the Westinghouse Hanford RARA program. Generally, an area is resurveyed after stabilization to assure that the radiation has been removed or contained.

Units subject to collapse of containment structures pose a potential threat of exposure by release of contaminants to the surface. However, none of the waste management units identified for the Semi-Works Aggregate Area are likely to pose a risk of release by this mechanism because the engineered units (e.g., cribs) do not contain void, spaces or are of materials (e.g., concrete) that is not prone to degradation.

5.2.3 Inhalation of Volatiles

As summarized in Section 4.1, the distribution of volatile organics in soils is not well-defined in the Semi-Works Aggregate Area. Although several volatile compounds, such as MIBK and tributyl phosphate, may have been disposed of in the cribs, no information is available on whether these compounds are still available in the near surface soil column for transport to the soil surface.

The primary volatile radionuclide of concern is tritium. Exposure to tritium, as tritiated water vapor, and the potential for tritium release via radiolytic production of hydrogen from aqueous radioactive wastes is of concern. Based on the radionuclide inventory, tritium was disposed of to the cribs and may therefore be available to volatilize through vent pipes or other outlets.

5.2.4 Migration to Groundwater

Risks that could potentially occur due to migration of contaminants in groundwater to existing or potential receptors will be addressed in the 200 East Groundwater AAMS and thus, will not be discussed in the Semi-Works AAMS. However, the potential for individual units to impact groundwater has been discussed in Section 4.1.

5.3 ADDITIONAL SCREENING CRITERIA

In addition to determining human health concerns for a worker at each of the waste management units, previously developed site ranking criteria were investigated for the purpose of setting priorities for waste management units and unplanned releases. These criteria are the CERCLA HRS scores assigned during preliminary assessment/site inspection (PA/SI) activities performed for the Hanford Site (DOE 1988a), and the rankings assigned by the Westinghouse Hanford Environmental Protection Group to prioritize sites needing remedial actions for radiological control (Huckfeldt 1991).

Both of these ranking systems take into account some measure of hazard and environmental mobility, and are thus appropriate to consider for waste unit prioritization. The HRS ranking system evaluates sites based on their relative risk, taking into account the population at risk, the hazard potential of the substances at the facility, the potential for contamination of the environment, the potential risk of fire and explosion, and the potential for injury associated with humans or animals that come into contact with the waste management unit inventory. The HRS is thus appropriate to consider for screening waste management units.

The PA/SI screening was performed using the EPA's HRS and mHRS. The HRS (40 CFR 300) is a site ranking methodology which was designed to determine whether sites should be placed on the CERCLA NPL based on chemical contamination history. The EPA has established the criteria for placement on the NPL to be a score of 28.5 or greater. The mHRS is a ranking system developed by the PNL for the U.S. DOE that uses the basic methodology of the HRS; however, it more accurately predicts the impacts from radionuclides. The mHRS takes into account concentration, half-life, and other chemical-specific parameters that are not considered by the HRS. The mHRS has not been accepted by EPA as a ranking system.

Many of the Semi-Works Aggregate Area waste management units were ranked in the PA/SI using both the HRS and mHRS. For those waste management units that were not ranked in the PA/SI, unit type and discharge history were evaluated in comparison

1 with ranked units for the purpose of setting priorities. If a waste management unit that
2 has been ranked exhibits similar characteristics, such as construction, waste type, and
3 volume, the value for the ranked unit was applied to the unit without an HRS or mHRS
4 score. If no ranked waste management units exhibit similar characteristics, then the unit
5 was not ranked; however, a high or low score was determined qualitatively through
6 evaluation of unit configuration and contamination history.

7
8 Table 5-1 lists the HRS and mHRS rankings, as well as scores that were assigned
9 for unranked waste management units, based on their similarity to ranked units in terms
10 of type, construction, and quantity of waste disposed of. If no similar waste management
11 units were available for comparison, the units were not ranked but were assigned a
12 qualitative indicator of migration potential.

13
14 Two of the 25 Semi-Works Aggregate Area waste management units were given a
15 score of 28.5 or greater with both the HRS and mHRS rankings. The remaining 23 units
16 were assigned a score below 1.5 or were assigned a qualitative "low" score. The units
17 that received "low" scores were given such a ranking because there is little or no known
18 history of liquid hazardous material disposal to the unit that could affect groundwater
19 beneath the Semi-Works Aggregate Area.

20
21 None of the 25 waste management units have been assigned an Environmental
22 Protection Group Score; thus, this criterion was not used for identifying high priority
23 units for this Aggregate Area.

24 25 26 5.4 SUMMARY OF SCREENING RESULTS

27
28 The screening process was used to sort sites as either high priority or low priority.
29 Table 5-1 lists the Semi-Works Aggregate Area waste management units that exceeded
30 one or more of the screening criteria identified in the preceding sections. In total, two of
31 the 25 units were identified as high priority.

32
33 Both of the high priority units were classified as such due to receiving HRS and
34 mHRS scores of 28.5 or greater. For three other units, the 241-CX-70 and 241-CX-72
35 Storage Tanks and 216-C-2 Reverse Well, radiation surveys do not reflect the current
36 status of the site, due to placement of the ash barrier at the 216-C-2 Reverse Well or
37 because the soil surface has been disturbed or covered since the survey was made at the
38 241-CX-70 and 241-CX-72 Storage Tanks. The placement of this ash barrier has the
39 effect of reducing the potential for contact with the radioactive surfaces and thus
40 reducing the potential hazard associated with these units.

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Table 5-1. Identification of High Priority Waste Management Units for the Semi-Works Aggregate Area. (Sheet 1 of 2)

Waste Management Unit	HRS Rating	mHRS Rating	Radiation Surveys			Environmental Protection Score	Priority
			ct/min	dis/min	mrem/hr		
Plants, Buildings, and Storage Areas							
201-C Process Building	Low	Low	NA	NA	2.5 to 1,500		Low ^c
291-C Ventilation System	Low	Low	350	NA	NA		Low ^c
Tanks and Vaults							
241-CX-70 Storage Tank	Low	Low	NA	17,000	NA		Low ^b
241-CX-71 Storage Tank	Low	Low	NA	NA	NA		Low
241-CX-72 Storage Tank	Low	Low	NA	15,000	NA		Low ^b
Cribs and Drains							
216-C-1 Crib	50.34	39.23	ND	ND	NA		High
216-C-3 Crib	1.04	1.14	ND	ND	ND		Low
216-C-4 Crib	1.09	1.14	ND	ND	ND		Low
216-C-5 Crib	1.09	0.82	ND	ND	NA		Low
216-C-6 Crib	1.04	1.14	ND	ND	NA		Low
216-C-7 Crib	1.04 ^a	1.14 ^a	ND	ND	ND		Low
216-C-10 Crib	47.82	33.29	NA	ND	ND		High
Reverse Wells							
216-C-2 Reverse Well	Low	Low	500	ND	ND		Low ^c
Ponds, Ditches, and Trenches							
216-C-9 Pond	Low	Low	NA	NA	NA		Low
200 East Powerhouse Ditch	Low	Low	NA	NA	NA		Low

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Table 5-1. Identification of High Priority Waste Management Units for the Semi-Works Aggregate Area. (Sheet 2 of 2)

Waste Management Unit	HRS Rating	mHRS Rating	Radiation Surveys			Environmental Protection Score	Priority
			ct/min	dis/min	mrem/hr		
Septic Tanks and Associated Drain Fields							
2607-E-5 Septic Tank and Drain Field	Low	Low	NA	NA	NA		Low
2607-E-7A Septic Tank and Drain Field	Low	Low	NA	NA	NA		Low
Transfer Facilities, Diversion Boxes, and Pipelines							
Semi-Works Valve Pit	Low	Low	NA	NA	NA		Low
Critical Mass Laboratory Valve Pit	Low	Low	NA	NA	NA		Low
241-C-154 Diversion Box	Low	Low	NA	NA	NA		Low
Burial Sites							
218-C-9 Burial Ground	Low	Low	NA	NA	NA		Low
Unplanned Releases							
UN-200-E-36	1.25	1.30	ND	ND	ND		Low
UN-200-E-37	1.25	1.30	NA	ND	NA		Low
UN-200-E-98	Low	Low	NA	NA	NA		Low
UN-200-E-141	Low	Low	NA	NA	NA		Low

Notes:

NA No radiation survey measurement was located for this parameter.

ND Radiation was measured but not detected.

Blank entries indicate no applicable data found during document review.

^a Score assigned based on similarity to the 216-C-6 Crib.^b Radiation surveys of tanks do not reflect current status of tank areas. Tank 241-CX-70 is currently covered by a plastic structure to allow access to the tank through an excavation. Tank 241-CX-72 area was covered with a concrete slab. Radiation survey was not used to prioritize units.^c Radiation survey was performed before placement of ash barrier (1987). Radiation survey was not used to prioritize unit.

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1
2
3 **6.0 IDENTIFICATION OF POTENTIALLY APPLICABLE OR RELEVANT**
4 **AND APPROPRIATE REQUIREMENTS**
5 **FOR THE SEMI-WORKS AGGREGATE AREA**
6
7

8 **6.1 INTRODUCTION**
9
10

11 The Superfund Amendments and Reauthorization Act (SARA) of 1986 amended
12 CERCLA to require that all ARARs be employed during implementation of a hazardous
13 waste site cleanup. "Applicable" requirements are defined by the EPA in "CERCLA
14 Compliance with Other Laws Manual" (OSWER Directive 9234.1-01, August 8, 1988) as:
15

16 cleanup standards, standards of control, and other substantive environmental
17 protection requirements, criteria, or limitations promulgated under federal or state
18 law that specifically address a hazardous substance, pollutant, contaminant,
19 remedial action, location, or other circumstance at a CERCLA site.
20

21 A separate set of "relevant and appropriate" requirements that must be evaluated
22 include:
23

24 cleanup standards, standards of control, and other substantive environmental
25 protection requirements, criteria, or limitations promulgated under federal or state
26 law that while not "applicable" to a hazardous substance, pollutant, contaminant,
27 remedial action, location, or other circumstance at a CERCLA site, address
28 problems or situations sufficiently similar to those encountered at the CERCLA
29 site that their use is well suited to the particular site.
30

31 "To-be-Considered Materials" (TBCs) are nonpromulgated advisories or guidance
32 issued by federal or state governments that are not legally binding and do not have the
33 status of potential ARARs. However, in many circumstances, TBCs will be considered
34 along with potential ARARs and may be used in determining the necessary level of
35 cleanup for protection of health or the environment.
36

37 The following sections identify potential ARARs to be used in developing and
38 assessing various remedial action alternatives at the Semi-Works Aggregate Area.
39 Specific potential requirements pertaining to hazardous and radiological waste
40 management, remediation of contaminated soils, surface water protection, and air quality
41 will be discussed.
42

1 The potential ARARs focus on federal or state statutes, regulations, criteria, and
2 guidelines. The specific types of potential ARARs evaluated include the following:

- 3
- 4 • Contaminant-specific
- 5
- 6 • Location-specific
- 7
- 8 • Action-specific.
- 9

10 Contaminant-specific potential ARARs are usually health or risk-based numerical
11 values or methodologies that, when applied to site-specific conditions, result in the
12 establishment of numerical contaminant values that are generally recognized by the
13 regulatory agencies as allowable to protect human health and the environment. In the
14 case of the Semi-Works Aggregate Area, contaminant-specific potential ARARs address
15 chemical constituents and/or radionuclides. The potential contaminant-specific ARARs
16 that were evaluated for the Semi-Works Aggregate Area are discussed in Section 6.2.

17
18 Location-specific potential ARARs are restrictions placed on the concentration of
19 hazardous substances, or the conduct of activities, solely because they occur in specific
20 locations. The location-specific potential ARARs that were evaluated for the Semi-
21 Works Aggregate Area are discussed in Section 6.3.

22
23 Action-specific potential ARARs apply to particular remediation methods and
24 technologies, and are evaluated during the detailed screening and evaluation of
25 remediation alternatives. The action-specific potential ARARs that were evaluated for
26 the Semi-Works Aggregate Area are discussed in Section 6.4.

27
28 The TBC requirements are other federal and state criteria, advisories, and
29 regulatory guidance that are not promulgated regulations, but are to be considered in
30 evaluating alternatives. Potential TBCs include DOE Orders that carry out authority
31 granted under the Atomic Energy Act. All DOE Orders are potentially applicable to
32 operations at the Semi-Works Aggregate Area. Specific TBC requirements are discussed
33 in Section 6.5.

34
35 Contaminant- and location-specific potential ARARs will be refined during the
36 AAMS process. Action-specific potential ARARs are briefly discussed in this section,
37 and will be further evaluated upon final selection of remedial alternatives. The points at
38 which these potential ARARs must be achieved and the timing of the evaluations are
39 discussed in Sections 6.6 and 6.7, respectively.
40
41

6.2 CONTAMINANT-SPECIFIC REQUIREMENTS

A contaminant-specific requirement sets concentration limits in various environmental media for specific hazardous substances, pollutants, or contaminants. Based on available information, some of the currently known or suspected contaminants that may be present in the Semi-Works Aggregate Area are outlined in Table 4-16. The currently identified federal and state contaminant-specific potential ARARs are summarized below.

6.2.1 Federal Requirements

Potential federal contaminant-specific requirements are specified in several statutes, codified in the U.S. Code (USC), and promulgated in the Code of Federal Regulations (CFR), as follows:

6.2.1.1 Clean Water Act. Federal Water Quality Criteria (FWQC) are developed under the authority of the Clean Water Act to serve as guidelines to the states for determining receiving water quality standards. Different FWQC are derived for protection of human health and protection of aquatic life. The human health FWQC are further subdivided according to how people are expected to use the water (e.g., drinking the water versus consuming fish caught from the water). SARA 121(d)(2) states that remedial actions shall attain FWQC where they are relevant and appropriate, taking into account the designated or potential use of the water, the media affected, the purpose of the criteria, and current information. Many more substances have FWQC than maximum contaminant levels (MCLs) issued under the Safe Drinking Water Act (see discussion below); consequently, EPA and other state agencies rely on these criteria more than MCLs, even though these criteria can only be considered relevant and appropriate and not applicable.

FWQC would not be considered at Semi-Works Aggregate Area, as no natural surface water bodies exist in the Semi-Works Aggregate Area. The only existing man-made surface water bodies at Semi-Works Aggregate Area are waste management units.

6.2.1.2 Safe Drinking Water Act. Under the authority of the Safe Drinking Water Act, MCLs apply when the water may be used for drinking. At present, EPA and the State of Washington apply MCLs as the standards for groundwater contaminants at CERCLA sites that could be used as drinking water sources. Groundwater contamination and application of MCLs as potential ARARs are addressed under a separate AAMS specific to groundwater.

6.2.1.3 Resource Conservation and Recovery Act. RCRA addresses the generation and transportation of hazardous waste, and waste management activities at facilities that treat, store, or dispose of hazardous wastes. Subtitle C (Hazardous Waste Management) mandates the creation of a cradle-to-grave management and permitting system for hazardous wastes. RCRA defines hazardous wastes as "solid wastes" (even though the waste is often liquid in physical form) that may cause or significantly contribute to an increase in mortality or serious illness, or that poses a substantial hazard to human health or the environment when improperly managed. In Washington State, RCRA is implemented by EPA and the authorized state agency, the Washington State Department of Ecology (Ecology).

RCRA is potentially applicable or relevant and appropriate to the Semi-Works Aggregate Area. The extensive permitting requirements under RCRA would only apply to a waste management unit that is an identified hazardous waste TSD facility, and to hazardous waste management activities that occurred outside an area of contamination. If a waste management unit is not a RCRA TSD facility and if remediation occurs on site, then the RCRA permitting requirements would not have to be satisfied. However, other substantive requirements necessary to protect human health and the environment would constitute potential ARARs.

Two key contaminant-specific potential ARARs have been adopted under the federal hazardous waste regulations: the Toxicity Characteristic Leaching Procedure (TCLP) designation limits promulgated under 40 CFR Part 261; and the hazardous waste land disposal restrictions for constituent concentrations promulgated under 40 CFR Part 268.

The TCLP designation limits define when a waste is hazardous, and are used to determine when more stringent management standards apply than would be applied to typical solid wastes. Thus, the TCLP contaminant-specific potential ARARs can be used to determine when RCRA waste management standards may be required. The TCLP limits are presented in Table 6-1.

The land disposal restrictions are numerical limits derived by EPA by reviewing available technologies for treating hazardous wastes. Until a prohibited waste can meet the numerical limits, it can be prohibited from land disposal. Two sets of limits have been promulgated: limits for constituent concentrations in waste extract, which uses the TCLP test to obtain a leached sample of the waste; and limits for constituent concentrations in waste, which addresses the total contaminant concentration in the waste. The land disposal restrictions limits are presented in Table 6-1 (see Section 6.4.1.2 for a further discussion on applying the land disposal restriction limits).

1 **6.2.1.4 Clean Air Act.** The Clean Air Act establishes National Primary and Secondary
2 Ambient Air Quality Standards (NAAQS) (40 CFR Part 50), National Emission
3 Standards for Hazardous Air Pollutants (NESHAP)(40 CFR Part 61), and New Source
4 Performance Standards (NSPS)(40 CFR Part 60).
5

6 In general, new and modified stationary sources of air emissions must undergo a
7 pre-construction review to determine whether the construction or modification of any
8 source, such as a CERCLA remedial program, will interfere with attainment or
9 maintenance of NAAQS or fail to meet other new source review requirements including
10 NESHAP and NSPS. However, the process applies only to "major" sources of air
11 emissions (defined as emissions of 250 tons per year). The Semi-Works Aggregate Area
12 would not constitute a major source.
13

14 Section 112 of the Clean Air Act directs EPA to establish standards at the level
15 that provides an ample margin of safety to protect the public health from hazardous air
16 pollutants. The NESHAP standards for radionuclides are directly applicable to DOE
17 facilities under Subpart H of Section 112 that establishes a 10 mrem/year facility-wide
18 standard during cleanup of the site. Further, if the maximum individual dose added by a
19 new construction or modification during remediation exceeds one percent of the
20 NESHAP standard (0.1 mrem/yr), a report meeting the substantive requirements of an
21 application for approval of construction must be prepared.
22
23

24 **6.2.2 State of Washington Requirements**

25

26 Potential state contaminant-specific requirements are specified in several statutes,
27 codified in the Revised Code of Washington (RCW) and promulgated in the Washington
28 Administrative Code (WAC).
29

30 **6.2.2.1 Model Toxics Control Act.** The Model Toxics Control Act (Ecology, 1991)
31 authorized Ecology to adopt cleanup standards for remedial actions at hazardous waste
32 sites. These regulations are considered potential ARARs for soil, groundwater, and
33 surface water cleanup actions. The processes for identifying, investigating, and cleaning
34 up hazardous waste sites are defined and cleanup standards are set for groundwater, soil,
35 surface water, and air in Chapter 173-340 WAC.
36

37 Under the Model Toxics Control Act regulations, cleanup standards may be
38 established by one of three following methods:
39

- 40 • Method A may be used if a routine cleanup action, as defined in WAC
41 173-340-200, is being conducted at the site or relatively few hazardous

substances are involved for which cleanup standards have been specified by Tables 1, 2, or 3 of WAC 173-340-720 through -745.

- Under Method B, a risk level of 10^{-6} is established and a risk calculation based on contaminants present is determined.
- Method C cleanup standards represent concentrations that are protective of human health and the environment for specified site uses. Method C cleanup standards may be established where it can be demonstrated that such standards comply with applicable state and federal laws, that all practical methods of treatment are used, that institutional controls are implemented, and that one of the following conditions exists: (1) Method A or B standards are below background concentrations; (2) Method A or Method B results in a significantly greater threat to human health or the environment; (3) Method A or Method B standards are below technically possible concentrations, or (4) the site is defined as an industrial site for purposes of soil remediation.

Table 1 of Method A addresses groundwater, so it is not considered to be a potential ARAR for Semi-Works Aggregate Area (groundwater will be addressed in the 200 East Groundwater AAMS report). Table 2 of Method A is intended for non-industrial site soil cleanups, and Table 3 of Method A is intended for industrial site soil cleanups. Method A industrial soil cleanup standards for preliminary contaminants of concern are provided as potential ARARs in Table 6-1.

In addition to Method A, Method B and Method C cleanup standards may also be considered potential ARARs for the Semi-Works Aggregate Area. Method B and Method C cleanup standards can be calculated on a case-by-case basis in concert with Ecology. Method B and Method C should be used where Method A standards do not exist or cannot be met, or where routine cleanup actions cannot be implemented at a specific waste management unit.

6.2.2.2 State Hazardous Waste Management Act and Dangerous Waste Regulations.

The State of Washington is a RCRA-authorized state for hazardous waste management, and has developed state-specific hazardous waste regulations under the authority of the State Hazardous Waste Management Act. Generally, state hazardous waste regulations parallel the federal regulations. The state definition of a hazardous waste incorporates the EPA designation of hazardous waste that is based on the compound being specifically listed as hazardous, or on the waste exhibiting the properties of reactivity, ignitability, corrosivity, or toxicity as determined by the TCLP.

1 In addition, Washington State identifies other waste as hazardous. Three unique
2 criteria are established: toxic dangerous waste; persistent dangerous waste; and
3 carcinogenic dangerous waste. These additional designation criteria may be imposed by
4 Ecology as potential ARARs, for purposes of determining acceptable cleanup standards
5 and appropriate waste management standards.
6

7 **6.2.2.3 Ambient Air Quality Standards and Emission Limits for Radionuclides (Chapter**
8 **173-480 WAC).** These Ecology ambient air quality standards specify maximum
9 accumulated dose limits to members of the public.
10

11 **6.2.2.4 Monitoring and Enforcement of Air Quality and Emission Standards for**
12 **Radionuclides (WAC 246-247).** These permitting requirements by the Washington State
13 Department of Health (Health) adopt the Ecology standards for maximum accumulated
14 dose limits to members of the public.
15

16 **6.2.2.5 Controls for New Sources of Toxic Air Pollutants (Chapter 173-460 WAC).** In
17 accordance with regulations recently promulgated by Ecology in Chapter 173-460 WAC,
18 any new emission source will be subject to Toxic Air Pollutant emission standards. The
19 regulations establish allowable ambient source impact levels (ASILs) for hundreds of
20 organic and inorganic compounds. Ecology's ASILs may constitute potential ARARs for
21 cleanup activities that have a potential to affect air. ASILs for preliminary contaminants
22 of concern are provided in Table 6-1.
23

24 **6.2.2.6 Water Quality Standards.** Washington State has promulgated various numerical
25 standards related to surface water and groundwater contaminants. These are included
26 principally in the following regulations:
27

- 28 • **Public Water Supplies (Chapter 248-54 WAC).** This regulation establishes
29 drinking water standards for public water supplies. The standards
30 essentially parallel the federal drinking water standards (40 CFR Parts 141
31 and 143).
32
- 33 • **Water Quality Standards for Ground Waters of the State of Washington**
34 **(Chapter 173-200 WAC).** This regulation establishes contaminant standards
35 for protecting existing and future beneficial uses of groundwater through
36 the reduction or elimination of the discharge of contaminants to the state's
37 groundwater.
38

- **Water Quality Standards for Surface Waters of the State of Washington (Chapter 173-201 WAC and Proposed Chapter 173-203/173-201A WAC).** Ecology has adopted numerical ambient water quality criteria for six conventional pollutant parameters for various surface water classes (WAC 173-201-045): (1) fecal coliform bacteria; (2) dissolved oxygen; (3) total dissolved gas; (4) temperature; (5) pH; and (6) turbidity. In addition, toxic, radioactive, or deleterious material concentrations shall be below those of public health significance or which may cause acute or chronic toxic conditions to the aquatic environment or which may adversely affect any water use. Numerical criteria currently exist for a limited number of toxic substances (WAC 173-201-047). Ecology has initiated rulemaking to modify and incorporate additional numerical criteria for toxic substances and for radioactive substances, and to reclassify certain waters of the state.

Under the state Water Quality Standards, the criteria and classifications do not apply inside an authorized mixing zone surrounding a wastewater discharge. In defining mixing zones, Ecology generally follows guidelines contained in "Criteria for Sewage Works Design." Although water quality standards can be exceeded inside the mixing zone, state regulations will not permit discharges that cause mortalities of fish or shellfish within the zone or that diminish aesthetic values.

These water quality standards do not constitute potential ARARs for purposes of establishing cleanup standards for the Semi-Works Aggregate Area. Groundwater is being addressed under a separate study in which pertinent groundwater-related potential ARARs will be covered. No surface water bodies exist within the Semi-Works Aggregate Area, so there will be no need to achieve ambient water quality standards during remediation activities.

The numerical water quality standards cited above may become potential ARARs if selected remedial actions could result in discharges to groundwater or surface water (e.g., if treated wastewaters are discharged to the soil column or the Columbia River). Determining appropriate standards for such discharges will depend on the type of remediation performed and will have to be established on a case-by-case basis as remedial actions are defined.

6.2.3 National Pollutant Discharge Elimination System (Chapter 173-220 WAC and 40 CFR Part 122) and Water Quality Standards.

National Pollutant Discharge Elimination System (NPDES) regulations govern point source discharges into navigable waters. Limits on the concentrations of

1 contaminants and volumetric flowrates that may be discharged are determined on a case-
2 by-case basis and permitted under this program. No point source discharges have been
3 identified. The EPA implements this program in Washington State for federal facilities;
4 however, assumption of the NPDES program by the state is likely within five years.

6.3 LOCATION-SPECIFIC REQUIREMENTS

9 Location-specific potential ARARs are restrictions placed on the concentration of
10 hazardous substances or the conduct of activities solely because they are in specific
11 locations. Some examples of special locations include floodplains, wetlands, historic
12 places, and sensitive ecosystems or habitats.

13
14 Table 6-2 lists various location-specific standards and indicates which of these may
15 be potential ARARs. Potential ARARs have been identified as follows:

- 16
17 • **Floodplains.** Requirements for protecting floodplains are not potential
18 ARARs for activities conducted within the Semi-Works Aggregate Area.
19 However, remedial actions selected for cleanup may require projects in or
20 near floodplains (e.g., construction of a treatment facility outfall at the
21 Columbia River). In such cases, location-specific floodplain requirements
22 may be potential ARARs.
- 23
24 • **Wetlands, Shorelines, and Rivers and Streams.** Requirements related to
25 wetlands, shorelines, and rivers and streams are not potential ARARs for
26 activities conducted within the Semi-Works Aggregate Area. However,
27 remedial actions selected for cleanup may require projects on a shoreline
28 or wetland, or discharges to wetlands (e.g., construction of a treatment
29 facility outfall at the Columbia River). In such cases, location-specific
30 shoreline and wetlands requirements may be potential ARARs.
- 31
32 • **Threatened and Endangered Species Habitats.** As discussed in Section 3.6,
33 various threatened and endangered species inhabit portions of the Hanford
34 Site and may occur in the Semi-Works Aggregate Area (American
35 peregrine falcon, bald eagle, white pelican, and sandhill crane). Therefore,
36 critical habitat protection for these species would constitute a potential
37 ARAR.
- 38
39 • **Wild and Scenic Rivers.** The Columbia River Hanford Reach is currently
40 undergoing study pursuant to the federal Wild and Scenic Rivers Act.
41 Pending results of this study, actions that may impact the Hanford Reach
42 may be restricted. This requirement would not be a potential ARAR for

remedial activities within the Semi-Works Aggregate Area. However, Wild and Scenic Rivers Act requirements may be potential ARARs for actions taken as a result of Semi-Works cleanup efforts that could affect the Hanford Reach.

6.4 ACTION-SPECIFIC REQUIREMENTS

Action-specific potential ARARs are requirements that are triggered by specific remedial actions. These remedial actions will not be fully defined until a remedial approach has been selected. However, the universe of action-specific ARARs defined by a preliminary screening of potential remedial action alternatives will help focus the selection process. Action-specific potential ARARs are outlined below. (Note that contaminant- and location-specific potential ARARs discussed above will also include provisions for action-specific potential ARARs to be applied once the remedial action is selected.)

6.4.1 Federal Requirements

6.4.1.1 Comprehensive Environmental Response, Compensation, and Liability Act. CERCLA, and regulations adopted pursuant to CERCLA contained in the National Contingency Plan (40 CFR Part 300), include selection criteria for remedial actions. Under the criteria, excavation and off-site land disposal options are least favored when on-site treatment options are available. Emphasis is placed on alternatives that permanently treat or immobilize contamination. Selected alternatives must be protective of human health and the environment, which implies that federal and state potential ARARs be met. However, a remedy may be selected that does not meet all potential ARARs if the requirement is technically impractical, if its implementation would produce a greater risk to human health or the environment, if an equivalent level of protection can otherwise be provided, if state standards are inconsistently applied, or if the remedy is only part of a complete remedial action which attains potential ARARs.

CERCLA gives state cleanup standards essentially equal importance as federal standards in guiding cleanup measures in cases where state standards are more stringent. State standards pertain only if they are generally applicable, were passed through formal means, were adopted on the basis of hydrologic, geologic, or other pertinent considerations, and do not preclude the option of land disposal by a state-wide ban. Most importantly, CERCLA provides that cleanup of a site must ensure that public health and the environment are protected. Selected remedies should meet all potential ARARs, but issues such as cost-effectiveness must be weighed in the selection process.

6.4.1.2 Resource Conservation and Recovery Act. RCRA, and regulations adopted pursuant to RCRA, describe numerous action-specific requirements that may be potential ARARs for cleanup activities. The primary regulations are promulgated under 40 CFR Parts 262, 264, and 265, and include such action-specific requirements as:

- Packaging, labeling, placarding, and manifesting of off-site waste shipments;
- Inspecting waste management areas to ensure proper performance and safe conditions;
- Preparation of plans and procedures to train personnel and respond to emergencies;
- Management standards for containers, tanks, incinerators, and treatment units;
- Design and performance standards for land disposal facilities; and
- Groundwater monitoring system design and performance.

Many of these requirements will depend on the particular remediation activity undertaken, and will have to be identified as remediation proceeds.

One key area of action-specific RCRA potential ARARs are the 40 CFR Part 268 land disposal restrictions. In addition to the contaminant-specific constituent concentration limits established in the land disposal restrictions (as previously discussed in Section 6.2.1.3), EPA has identified best demonstrated available treatment technologies (BDATs) for various waste streams. EPA could require the use of BDATs prior to allowing land disposal of wastes generated during remediation. EPA's imposition of the land disposal restrictions and BDAT requirements will depend on various factors.

Applicability to CERCLA actions is based on determinations of waste "placement/disposal" during a remediation action. According to OSWER Directive 9347.3-05FS, EPA concludes that Congress did not intend in situ consolidation, remediations, or improvement of structural stability to constitute placement or disposal. Placement or disposal would be considered to occur if:

- Wastes from different units are consolidated into one unit (other than a land disposal unit within an area of contamination);

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- Waste is removed and treated outside a unit and redeposited into the same or another unit (other than a land disposal unit within an area of contamination); or
- Waste is picked up from a unit and treated within the area of contamination in an incinerator, surface impoundment, or tank and then redeposited into the unit (except for in situ treatment).

Consequently, the requirement to use BDAT would not apply under the land disposal restrictions standards unless placement or disposal had occurred. However, remediation actions involving excavation and treatment could trigger the requirements to use BDAT for wastes subject to the land disposal restrictions standards. In addition, the agencies could consider BDAT technologies to be relevant and appropriate when developing and evaluating potential remediation technologies.

Two additional components of the land disposal restrictions program should be considered with regard to an excavate and treat remedial action. First, a national capacity variance was issued by EPA for contaminated soil and debris for a two-year period ending May 8, 1992 (54 FR 26640). Second, a series of variances and exemptions may be applied under an excavate and treat scenario. These include:

- A no-migration petition
- A case-by-case extension to an effective date
- A treatability variance
- Mixed waste provisions of a federal Facilities Compliance Act (when enacted).

The applicability and relevance of each of these options will vary based on the specific details of a Semi-Works Aggregate Area excavate and treat option. An analysis of these variances can be developed once engineering data on the option becomes available.

The effect of the land disposal restrictions program on mixed waste management is significant. Currently, limited technologies are available for effective treatment of these waste streams and no commercially available treatment facilities exist except for liquid scintillation counting fluids used for laboratory analysis and testing. The EPA recognized that inadequate capacity exists and issued a national capacity variance until May 8, 1992, to allow for the development of such treatment capacity.

1 Lack of treatment and disposal capacity also presents implications for storage of
2 these materials. Under 40 CFR 268.50, mixed wastes subject to land disposal restrictions
3 may be stored for up to one year. Beyond one year, the owner/operator has the burden
4 of proving such storage is for accumulating sufficient quantities for treatment. On
5 August 29, 1991, EPA issued a mixed waste storage enforcement policy providing some
6 relief from this provision for generators of small volumes of mixed wastes. However, the
7 policy was limited to facilities generating less than 28 m³ (1,000 ft³) of land disposal-
8 prohibited waste per year. Congress is considering amendments to RCRA postponing
9 the storage prohibition for another five years; however, final action on these amendments
10 has not occurred.

11
12 **6.4.1.3 Clean Water Act.** Regulations adopted pursuant to the Clean Water Act under
13 the NPDES mandate use of best available treatment technologies prior to discharging
14 contaminants to surface waters. NPDES requirements would not be potential ARARs
15 for actions conducted only within the Semi-Works Aggregate Area. However, NPDES
16 requirements could constitute potential ARARs for cleanup actions which would result in
17 discharge of treated wastewaters to the Columbia River, and associated treatment
18 systems could be required to utilize best available treatment technologies.

19
20 **6.4.1.4 Department of Transportation Standards.** The Department of Transportation
21 standards contained in 40 CFR Parts 171 through 177 specify the requirements of
22 packaging, labeling, and placarding for off-site transport of hazardous materials. These
23 standards ensure that hazardous substances and wastes are safely transported using
24 adequate means of transport and with proper documentation.

25
26 **6.4.1.5 Occupational Safety and Health Administration Standards.** The Occupational
27 Safety and Health Administration requirements contained in 29 CFR Part 1910 outline
28 standards for provision of safe and healthful places of employment for workers. 29 CFR
29 1910.120 specifically addresses standards for workers engaged in hazardous waste
30 operations and emergency response, and includes detailed standards on the procedures
31 and equipment required.

32 33 34 **6.4.2 State of Washington Requirements**

35
36 **6.4.2.1 Hazardous Waste Management.** As discussed in Section 6.4.1.2, there are various
37 requirements addressing the management of hazardous wastes that may be action-specific
38 potential ARARs. Pertinent Washington regulations appear in Chapter 173-303 WAC
39 and generally parallel federal management standards. Determination of potential
40 ARARs will be on a case-by-case basis as cleanup actions proceed.

6.4.2.2 **Solid Waste Management.** Washington State regulations describe management standards for solid waste in Chapter 173-304 WAC. Some of these management standards may be potential ARARs for disposal of cleanup wastes within the Semi-Works Aggregate Area. Solid waste standards include such requirements as:

- Inspecting waste management areas to ensure proper performance and safe conditions
- Management standards for incinerators and treatment units
- Design and performance standards for landfills
- Groundwater monitoring system design and performance.

Many of these requirements will depend on the particular remediation activity undertaken, and will have to be identified as remediation proceeds.

6.4.2.3 **Water Quality Management.** Chapter 90.48 RCW, the Washington State Water Pollution Control Act, requires use of all known, available, and reasonable treatment technologies for treating contaminants prior to discharge to waters of the state. Implementing regulations appear principally at Chapters 173-216, 173-220, and 173-240 WAC.

The Water Pollution Control Act requirements for groundwater could be potential ARARs for actions conducted within the Semi-Works Aggregate Area if such actions would result in discharge of liquid contaminants to the soil column. In this event, Ecology may require use of all known, available, and reasonable treatment technologies to treat the liquid discharges prior to soil disposal.

The Water Pollution Control Act requirements for surface water would not be ARARs for actions conducted only within the Semi-Works Aggregate Area. However, these requirements could constitute potential ARARs for cleanup actions which would result in discharge of treated wastewaters to the Columbia River and associated treatment systems could be required to demonstrate they meet all known, available, and reasonable treatment technologies.

6.4.2.4 **Air Quality Management.** The Toxic Air Pollutant regulations for new air emission sources, promulgated in Chapter 173-460 WAC, require use of best available control technology for air toxics. The Toxic Air Pollutant regulations may be potential ARARs for cleanup actions at the Semi-Works Aggregate Area that could result in emissions of toxic contaminants to the air. Ecology may require the use of best available control technology for air toxics, to treat such air emissions.

6.5 OTHER CRITERIA AND GUIDANCE TO BE CONSIDERED

In addition to the potential ARARs presented, other federal and state criteria, advisories, guidance, and similar materials are TBC in determining the appropriate degree of remediation for the Semi-Works Aggregate Area. A myriad of resources may be potentially evaluated. The following represents an initial assessment of pertinent TBC provisions.

6.5.1 Health Advisories

The EPA Office of Drinking Water publishes advisories identifying contaminants for which health advisories have been issued.

6.5.2 International Commission on Radiation Protection/National Council on Radiation Protection

The International Commission on Radiation Protection and the National Council on Radiation Protection have a guidance standard of 100 mrem/yr whole body dose of gamma radiation. These organizations also issue recommendations on other areas of interest regarding radiation protection.

6.5.3 EPA Proposed Corrective Actions for Solid Waste Management Units

In the July 27, 1990, federal register (55 FR 30798), EPA published proposed regulations for performing corrective actions (cleanup activities) at solid waste management units associated with RCRA facilities. The proposed 40 CFR Part 264 Subpart S include requirements that would be TBCs for determining an appropriate level of cleanup at the Semi-Works Aggregate Area. In particular, EPA included an appendix—Appendix A - Examples of Concentrations Meeting Criteria for Action Levels—which presented recommended contaminant concentrations warranting corrective action. These contaminant-specific TBCs are included in Table 6-1 for the preliminary contaminants of concern.

6.5.4 DOE Standards for Radiation Protection

A number of DOE Orders exist which could be TBCs. DOE Orders that establish potential contaminant-specific or action-specific standards for the remediation of radioactive wastes and materials are discussed below.

6.5.4.1 DOE Order 5400.5 - DOE Standards for Radiation Protection of the Public and Environment. DOE Order 5400.5 establishes the requirements for DOE facilities to protect the environment and human health from radiation including soil and air contamination. The purpose of the Order is to establish standards and requirements for operations of the DOE and DOE contractors with respect to protection of members of the public and the environment against undue risk from radiation.

The Order mandates that the exposure to members of the public from a radiation source as a consequence of routine activities shall not exceed 100 mrem from all exposure sources due to routine DOE activities. In accordance with the Clean Air Act, exposures resulting from airborne emissions shall not exceed 10 mrem to the maximally exposed individual at the facility boundary. DOE Order 5400.5 provides Derived Concentration Guide values for releases of radionuclides into the air or water. Derived Concentration Guide values are calculated so that, under conditions of continuous exposure, an individual would receive an effective dose equivalent of 100 mrem/year. Because dispersion in air or water is not accounted for in the Derived Concentration Guide, actual exposures of maximally exposed individuals in unrestricted areas are considerably below the 100 mrem/year level.

DOE Order 5400.5 also provides for establishment of soil cleanup levels through a site-specific pathway analysis such as the allowable residual contamination level method. The calculation of allowable residual contamination level values for radionuclides is dependent on the physical characteristics of the site, the radiation dose limit determined to be acceptable, and the scenarios of human exposure judged to be possible and to result in the upper-bound exposure.

6.5.4.2 DOE Order 5820.2A - Radioactive Waste Management. DOE Order 5820.2A applies to all DOE contractors and subcontractors performing work that involves management of waste containing radioactivity. This Order requires that wastes be managed in a manner that assures protection of the health and safety of the public, operating personnel, and the environment. DOE Order 5820.2A establishes requirements for management of high-level, transuranic, and low-level wastes as well as wastes containing naturally occurring or accelerator produced radioactive material, and for decommissioning of facilities. The requirements applicable to the Semi-Works Aggregate Area remediation activities include those related to transuranic waste and low-level radioactive waste. These are summarized below.

1 **6.5.4.2.1 Management of Transuranic Waste.** Transuranic waste resulting from
2 the Semi-Works Aggregate Area remedial action must be managed to protect the public
3 and worker health and safety, and the environment, and performed in compliance with
4 applicable radiation protection standards and environmental regulations. Practical and
5 cost-effective methods must be used to reduce the volume and toxicity of transuranic
6 waste.

7
8 Transuranic waste must be certified in compliance with the Waste Isolation Pilot
9 Plant (WIPP) Acceptance Criteria, placed in interim storage, if required, and sent to the
10 WIPP. Any transuranic waste that the DOE has determined, with the concurrence of the
11 EPA Administrator, does not need the degree of isolation provided by a geologic
12 repository or transuranic waste that cannot be certified or otherwise approved for
13 acceptance at the WIPP must be disposed of by alternative methods. Alternative
14 disposal methods must be approved by DOE Headquarters and comply with NEPA
15 requirements and EPA/state regulations.

16
17 **6.5.4.2.2 Management of Low-Level Radioactive Waste.** The requirements for
18 management of low-level radioactive waste presented in DOE Order 5820.2A are
19 relevant to the remedial alternative of removal and disposal of Semi-Works Aggregate
20 Area wastes. Performance objectives for this option shall ensure that external exposure
21 to the radioactive material released into surface water, groundwater, soil, plants, and
22 animals does not result in an effective dose greater than 25 mrem/yr to the public.
23 Releases to the environment shall be at levels as low as reasonably achievable. An
24 inadvertent intruder after the institutional control period of 100 years is not to exceed
25 100 mrem/yr for continuous exposure or 500 mrem for a single acute exposure. A
26 performance assessment is to be prepared to demonstrate compliance with the above
27 performance objectives.

28
29 Other requirements under DOE Order 5820.2A which may affect remediation of
30 the Semi-Works Aggregate Area include waste volume minimization, waste
31 characterization, waste acceptance criteria, waste treatment, and shipment. The low-level
32 radioactive waste may be stored by appropriate methods prior to disposal to achieve the
33 performance objectives discussed above. Disposal site selection, closure/post-closure, and
34 monitoring requirements are also discussed in this Order.

35 36 37 **6.6 POINT OF APPLICABILITY**

38
39 A significant factor in the evaluation of remedial alternatives for the Semi-Works
40 Aggregate Area will be the determination of the point at which compliance with potential
41 ARARs must be achieved (i.e., the point of a specific ARAR's applicability). These

1 points of applicability are the boundaries at which the effectiveness of a particular
2 remedial alternative will be assessed.

3
4 For most individual radioactive species transported by either water or air, Ecology
5 and Health standards generally require compliance at the boundaries of the Hanford
6 Site. The assumed point of compliance for radioactive species is the point where a
7 member of the public would have unrestricted access to live and conduct business, and,
8 consequently, to be maximally exposed. Although Health is responsible for monitoring
9 and enforcing the air standards promulgated by Ecology, and generally recognizes the site
10 boundary as the point of applicability, Ecology has recently indicated that compliance
11 may be required at the point of emission.

12
13 The point at which compliance with potential ARARs must be achieved will be a
14 significant factor in evaluating appropriate remedial alternatives in the Semi-Works
15 Aggregate Area. For example, it may be necessary to determine if potential ARARs
16 must be achieved at the point of discharge, at the boundary of the disposal unit, at the
17 boundary of the AAMS, at the boundary of the Hanford Site, and/or at the point of
18 maximum exposure.

19 20 21 **6.7 ARARs EVALUATION**

22
23 Evaluation of potential ARARs is an iterative process that will be conducted at
24 multiple points throughout the remedial process:

- 25
26 • When the public health evaluation is conducted to assess risks at the Semi-
27 Works Aggregate Area, the contaminant-specific potential ARARs and
28 advisories and location-specific potential ARARs will be identified more
29 comprehensively and used to help determine the cleanup goals
- 30
31 • During detailed analysis of alternatives, all the potential ARARs and
32 advisories for each alternative will be examined to determine what is
33 needed to comply with other laws and to be protective of public health and
34 the environment.

35
36 Following completion of the investigation, the remedial alternative selected must
37 be able to attain all potential ARARs unless one of the six statutory waivers provided in
38 Section 121 (d)(4)(A) through (f) of CERCLA is invoked. Finally, during remedial
39 design, the technical specifications of construction must ensure attainment of potential
40 ARARs. The six reasons potential ARARs can be waived are as follows:
41

- The remedial action is an interim measure, where the final remedy will attain ARARs upon completion.
- Compliance will result in greater risk to human health and the environment than will other options.
- Compliance is technically impracticable.
- An alternative remedial action will attain the equivalent performance of the ARAR.
- For state ARARs, the state has not consistently applied (or demonstrated the intention to consistently apply) the requirements in similar circumstances.
- For CERCLA-financed actions under Section 104, compliance with the ARAR will not provide a balance between the need for protecting public health, welfare, and the environment at the facility, and the need for fund money to respond to other sites (this waiver is not applicable at the Hanford Site).

Once investigations have been completed and final remedies have been selected, the ARARs that must be met will be formally identified in the ROD. Compliance with those ARARs specified in the ROD will be achieved during remedial action. ARARs may need to be re-evaluated if unanticipated circumstances are encountered during remediation which prevent the ability to satisfy the identified ARARs.

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Table 6-1. Potential Contaminant-Specific ARARs and TBCs for Preliminary Inorganic and Organic Contaminants of Concern. (Sheet 1 of 2)

	RCRA TCLP Designation Limits	RCRA Land Ban Limits Nonwastewater		MTCA Method A Cleanup Level Industrial Soil	WCAA Toxic Air Pollutants ASIL	RCRA Corrective Action Level (1) (Proposed)	
	in mg/L	CCWE in mg/L	CCW in mg/kg	in mg/kg	in $\mu\text{g}/\text{m}^3$	Air in $\mu\text{g}/\text{m}^3$	Soil in mg/kg
METALS							
Barium	100.0	100.0	—	—	1.7	0.4	4000.0
Bismuth	—	—	—	—	—	—	—
Boron	—	—	—	—	—	—	—
Cadmium	1.0	1.0	—	10.0	0.00056	0.0006	40.0
Chromium (VI)	5.0	5.0	—	500.0	0.000083	0.00009	40.0
Chromium (III)	5.0	—	—	500.0	1.7	—	—
Copper	—	—	—	—	3.3	—	—
Iron	—	—	—	—	—	—	—
Lead	5.0	5.0	—	1000.0	—	—	—
Manganese	—	—	—	—	16.7	—	—
Molybdenum	—	—	—	—	33.3	—	—
Nickel	—	—	—	—	—	—	2000.0
Palladium	—	—	—	—	—	—	—
Silver	5.0	5.0	—	—	0.3	—	—
Zinc	—	—	—	—	—	—	—

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Table 6-1. Potential Contaminant-Specific ARARs and TBCs for Preliminary Inorganic and Organic Contaminants of Concern. (Sheet 2 of 2)

	RCRA TCLP Designation Limits	RCRA Land Ban Limits Nonwastewater		MTCA Method A Cleanup Level Industrial Soil	WCAA Toxic Air Pollutants ASIL	RCRA Corrective Action Level (1) (Proposed)	
	in mg/L	CCWE in mg/L	CCW in mg/kg	in mg/kg	in $\mu\text{g}/\text{m}^3$	Air in $\mu\text{g}/\text{m}^3$	Soil in mg/kg
OTHER INORGANICS							
Ammonia	—	—	—	—	59.9	—	—
Ammonium bicarbonate	—	—	—	—	—	—	—
Calcium nitrate	—	—	—	—	—	—	—
Chromium nitrate	—	—	—	—	1.7	—	—
Ferric hydroxide	—	—	—	—	—	—	—
Ferric nitrate	—	—	—	—	—	—	—
Ferric sulfate	—	—	—	—	—	—	—
Ferrous sulfamate	—	—	—	—	—	—	—
Fluoride	—	—	—	—	8.3	—	—
Hydrazine	—	—	—	—	—	—	—
Lead nitrate	—	—	—	—	—	—	—
Nickel nitrate	—	—	—	—	—	—	—
Nitrate (as Nitrogen)	—	—	—	—	—	—	—
Nitrite (as Nitrogen)	—	—	—	—	—	—	—
Nitric acid	—	—	—	—	16.7	—	—
Nitric ferrous ammonium sulfate	—	—	—	—	—	—	—
Permanganate caustic	—	—	—	—	—	—	—
Silver nitrate	—	—	—	—	—	—	—
Sodium dichromate	—	—	—	—	—	—	—
Sodium fluoride	—	—	—	—	—	—	—
Sodium nitrate	—	—	—	—	—	—	—
Sodium nitrite	—	—	—	—	—	—	—
ORGANICS							
1-Butanol	—	5.0	2.6	—	—	499.5	—
Chloroform	6.0	—	5.6	—	0.043	0.04	100.0
Methyl isobutyl ketone	—	0.33	33.0	—	682.7	70.0	4000.0
Tributyl phosphate	—	—	—	—	8.3	—	—

FOOTNOTES

ASIL = Acceptable Source Impact Level
 CCWE = Constituent Concentration in Waste Extract
 CCW = Constituent Concentration in Waste
 MTCA = Washington State Model Toxics Control Act
 RCRA = Federal Resource Conservation and Recovery Act
 TCLP = Toxic Characteristic Leaching Procedure
 WCAA = Washington State Clean Air Act

mg/L = milligrams per liter
 mg/kg = milligrams per kilogram
 $\mu\text{g}/\text{m}^3$ = micrograms per cubic meter

(1) RCRA Corrective Action Levels are only proposed at this time (40 CFR Part 264 Subpart S), so are not ARARs yet; they are "To Be Considered".

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Table 6-2. Potential Location-Specific ARARs. (Sheet 1 of 5)

Location	Requirement	Prerequisite	Citation	ARAR
<u>GEOLOGICAL</u>				
Within 200 feet of a fault displaced in Holocene time	New treatment, storage or disposal of hazardous waste prohibited	Hazardous waste management near Holocene fault	40 CFR 264.18; WAC 173-303-420	Not ARAR. No Holocene fault.
Holocene faults and subsidence areas	New solid waste disposal facilities prohibited over faults with displacement in Holocene time, and in subsidence areas	New solid waste management activities near Holocene fault	WAC 173-304-130	Not ARAR. No Holocene fault.
Unstable slopes	New solid waste disposal areas prohibited from hills with unstable slopes	New solid waste disposal on an unstable slope	WAC 173-304-130	Not ARAR. No unstable slope.
100-year floodplains	Solid and hazardous waste disposal facilities must be designed, built, operated, and maintained to prevent washout	Solid or hazardous waste disposal in a 100-year floodplain	40 CFR 264.18; WAC 173-303-420; WAC 173-304-460	Potential ARAR.
	Avoid adverse effects, minimize potential harm, restore/preserve natural and beneficial values in floodplains	Actions occurring in a floodplain	40 CFR Part 6 Subpart A; 16 USC 661 <u>et seq</u> ; 40 CFR 6.302	Potential ARAR.
Salt dome and salt bed formations, underground mines, and caves	Placement of non-containerized or bulk liquid hazardous wastes is prohibited	Hazardous waste placement in salt dome, salt bed, mine, or cave	40 CFR 264.18	Not ARAR. None of these units.

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Table 6-2. Potential Location-Specific ARARs. (Sheet 2 of 5)

Location	Requirement	Prerequisite	Citation	ARAR
<u>SURFACE WATER</u>				
Wetlands	New hazardous waste disposal facilities prohibited in wetlands (including within 200 feet of shoreline)	Hazardous waste disposal within 200 feet of surface water	WAC 173-303-420	Potential ARAR.
	New solid waste disposal facilities prohibited within 200 feet of surface water (stream, lake, pond, river, salt water body)	Solid waste disposal within 200 feet of surface water	WAC 173-304-130	Potential ARAR.
	New solid waste disposal facilities prohibited in wetlands (swamps, marshes, bogs, estuaries, and similar areas)	Solid waste disposal in a wetland (swamp, marsh, bog, estuary, etc.)	WAC 173-304-130	Not ARAR. No wetlands present.
	Discharge of dredged or fill materials into wetlands prohibited without a permit	Discharges to wetlands and navigable waters	40 CFR Part 230; 33 CFR Parts 303, and 320 to 330	Potential ARAR.
	Minimize potential harm, avoid adverse effects, preserve and enhance wetlands	Construction or management of property in wetlands	40 CFR Part 6 Appendix A	Not ARAR. No wetlands present.
Shorelines	Actions prohibited within 200 feet of shorelines of statewide significance unless permitted	Actions near shorelines	Chapter 90.58 RCW; Chapter 173-14 WAC	Potential ARAR.
Rivers and streams	Avoid diversion, channeling or other actions that modify streams or rivers, or adversely affect fish or wildlife habitats and water resources	Actions modifying a stream or river and affecting fish or wildlife	40 CFR 6.302	Potential ARAR.

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Table 6-2. Potential Location-Specific ARARs. (Sheet 3 of 5)

Location	Requirement	Prerequisite	Citation	ARAR
<u>GROUNDWATER</u>				
Sole source aquifer	New solid and hazardous waste land disposal facilities prohibited over a sole source aquifer	Disposal over a sole source aquifer	WAC 173-303-402; WAC 173-304-130	Not ARAR. No sole source aquifer.
Uppermost aquifer	Bottom of lowest liner of new solid waste disposal facility must be at least 10 feet above seasonal high water in uppermost aquifer (5 feet if hydraulic gradient controls installed)	New solid waste disposal	WAC 173-304-130	Not ARAR. Groundwater is deeper than 10 feet.
Aquifer Protection Areas	Activities restricted within designated Aquifer Protection Areas	Activities within an Aquifer Protection Area	Chapter 36.36 RCW	Not ARAR. Not an Aquifer Protection Area
Groundwater Management Areas	Activities restricted within Ground Water Management Areas	Activities within a Groundwater Management Area	Chapter 90.44 RCW; Chapter 173-100 WAC	Not ARAR. Not a Groundwater Management Area.
<u>DRINKING WATER SUPPLY</u>				
Drinking water supply well	New solid waste disposal areas prohibited within 1000 feet upgradient, or 90 days travel time, of drinking water supply well	New solid waste disposal within 1000 feet of drinking water supply well	WAC 173-304-130	Not ARAR. No drinking water supply wells.
Watershed	New solid waste disposal areas prohibited within a watershed used by a public water supply system for municipal drinking water	New solid waste disposal in a public watershed	WAC 173-304-130	Not ARAR. Not a public watershed.
<u>AIR</u>				
Non-attainment areas	Restrictions on air emissions in areas designated as non-attainment areas under state and federal air quality programs	Activities in a designated non-attainment area	Chapter 70.94 RCW; Chapters 173-400 and 173-403 WAC	Not ARAR. Not a non-attainment area.

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Table 6-2. Potential Location-Specific ARARs. (Sheet 4 of 5)

Location	Requirement	Prerequisite	Citation	ARAR
<u>SENSITIVE ENVIRONMENTS</u>				
Endangered/threatened species habitats	New solid waste disposal prohibited from areas designated by US Fish and Wildlife Service as critical habitats for endangered/threatened species	New solid waste disposal in critical habitats	WAC 173-304-130	Not ARAR. Not a critical habitat.
Parks	Actions within critical habitats must conserve endangered/threatened species	Activities where endangered or threatened species exist	50 CFR Parts 200 and 402	Potential ARAR.
	No new solid waste disposal areas within 1,000 feet of state or national park	New solid waste disposal near state/national park	WAC 173-304-130	Not ARAR. No state/national park.
Wilderness areas	Restrictions on activities in areas that are designated state parks, or recreation/conservation areas	Activities in state parks or recreation/conservation areas	Chapter 43.51 RCW; Chapter 352-32 WAC	Not ARAR. None of these state areas.
	Actions within designated wilderness areas must ensure area is preserved and not impaired	Activities within designated wilderness areas	16 USC 1131 <i>et seq</i> ; 50 CFR 35.1 <i>et seq</i>	Not ARAR. Not a wilderness area.
Wildlife refuge	Restrictions on actions in areas that are part of the National Wildlife Refuge System	Activities within designated wildlife refuges	16 USC 668dd <i>et seq</i> ; 50 CFR Part 27	Not ARAR. Not a wildlife refuge.
Natural areas preserves	Activities restricted in areas designated as having special habitat value (Natural Heritage Resources)	Activities within identified Natural Area Preserves	Chapter 79.70 RCW; Chapter 332-60 WAC	Not ARAR. Not a Natural Area Preserve
Wild, scenic, or recreational rivers	Avoid actions that would have adverse effects on designated wild, scenic, or recreational rivers	Activities near wild, scenic, and recreational rivers	16 USC 1271 <i>et seq</i> ; 40 CFR 6.302; Chapter 79.72 RCW	Potential ARAR.
Columbia River Gorge	Restrictions on activities that could affect resources in the Columbia River Gorge	Activities within the Columbia River Gorge	Chapter 43.97 RCW	Not ARAR. Not in Columbia River Gorge.

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Table 6-2. Potential Location-Specific ARARs. (Sheet 5 of 5)

Location	Requirement	Prerequisite	Citation	ARAR
<u>UNIQUE LANDS AND PROPERTIES</u>				
Natural resource conservation areas	Restrictions on activities within designated Conservation Areas	Activities within designated Conservation Areas	Chapter 79.71 RCW	Not ARAR. Not a Conservation Area.
Forest lands	Activities restricted within state forest lands to minimize fire hazards and other adverse impacts	Activities within state forest lands	Chapter 76.04 RCW; Chapter 332-24 WAC	Not ARAR. Not a forest land.
Public lands	Restrictions on activities in state and federal forest lands	Activities within state and federal forest lands	16 USC 1601; Chapter 76.09 RCW	Not ARAR. Not a forest land.
	Activities on public lands are restricted, regulated or proscribed	Activities on state-owned lands	Chapter 79.01 RCW	Not ARAR. Not a state land.
Scenic vistas	Restrictions on activities that can occur in designated scenic areas	Activities in designated scenic vista areas	Chapter 47.42 RCW	Not ARAR. Not a scenic area.
Historic areas	Actions must be taken to preserve and recover significant artifacts, preserve historic and archaeologic properties and resources, and minimize harm to national landmarks	Activities that could affect historic or archaeologic sites or artifacts	16 UST 469, 470 <u>et seq</u> ; 36 CFR Parts 65 and 800; Chapters 27.34, 27.53 and 27.58 RCW	Not ARAR. No historic or archaeologic sites.
<u>LAND USE</u>				
Neighboring properties	No new solid waste disposal areas within 100 feet of the facility's property line	New solid waste disposal within 100 feet of facility property line	WAC 173-304-130	Not ARAR. Not near facility boundary.
	No new solid waste disposal areas within 250 feet of property line of residential zone properties	New solid waste disposal within 250 feet of property line of residential property	WAC 173-304-130	Not ARAR. No residential property near.
Proximity to airports	Disposal of garbage that could attract birds prohibited within 10,000 feet (turbojet aircraft)/ 5000 feet (piston-type aircraft) of airport runways	Garbage disposal near airport	WAC 173-304-130	Not ARAR. No airports near.

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7.0 PRELIMINARY REMEDIAL ACTION TECHNOLOGIES

Previous sections identified contaminants of concern at the Semi-Works Aggregate Area, potential routes of exposure, and ARARs. Section 7.0 identifies preliminary remedial action objectives (RAOs) and develops preliminary remedial action alternatives consistent with reducing the potential hazards of this contamination and satisfying ARARs. The overall objective of this section is to identify viable and innovative remedial action alternatives for media of concern at the Semi-Works Aggregate Area.

The process of identifying viable remedial action alternatives consists of several steps. In Section 7.1, RAOs are first identified. Next, in Section 7.2, general response actions are determined along with specific treatment, resource recovery, and containment technologies within the general response categories. Specific process options belonging to each technology type are identified, and these process options are subsequently screened based on their effectiveness, implementability, and cost (Section 7.3). The combining of process options into alternatives occurs in Section 7.4. Here the alternatives are described and diagrammed. Criteria are then identified in Section 7.5 for preliminary screening of alternatives that may be applicable to the waste management units and unplanned release sites identified in the Semi-Works Aggregate Area. Figure 7-1 is a matrix summarizing the development of the remedial action alternatives starting with media-specific RAOs.

Because of uncertainty regarding the nature and extent of contamination at the Semi-Works Aggregate Area waste management units, recommendations for remedial alternatives are general and cover a broad range of actions. Remedial action alternatives will be considered and more fully developed in future focused feasibility studies. The *Hanford Site Past-Practice Strategy* (DOE/RL 1992) is used to focus the range of remedial action alternatives that will be evaluated in focused studies. In general, the *Hanford Site Past-Practice Strategy* RI/FS and RCRA/Corrective Measures Studies are defined as the combination of IRMs, LFI for final remedy selection where interim actions are not clearly justified, and focused or aggregate area feasibility/treatability studies for further evaluation of treatment alternatives. After completion of an IRM, data will be evaluated including concurrent characterization and monitoring data to determine if a final remedy can be selected.

A secondary purpose of the evaluation of preliminary remedial action alternatives is the identification of additional information needed to complete the evaluation. This information may include field data needs and treatability tests of selected technologies. Additional data will be developed for most sites or waste groups during future data

1 gathering activities (e.g., LFIs, characterization supporting IRMs, or treatability studies).
2 These data may be used to refine and supplement the RAOs and proposed alternatives
3 identified in this initial study. Data needs are defined in Section 8.0. Alternatives
4 involving technologies that are not well-demonstrated under the conditions of interest are
5 identified in Sections 7.3 and 7.5. These technologies may require bench-scale and
6 pilot-scale treatability studies. The intent is to conduct treatability studies for promising
7 technologies early in the RI/FS process. Conclusions regarding the feasibility of some
8 individual technologies may change after new data become available.

9
10 The bias-for-action philosophy of addressing contamination at the Hanford Site
11 requires an expedited process for implementing remedial actions. Implementation of
12 general response actions may be accomplished using an observational or "learn-as-you-go"
13 approach. This observational approach is an iterative process of data acquisition and
14 refinement of the conceptual model. Data needs are determined by the model, and data
15 collected to fulfill these needs are used as additional input to the model. Use of the
16 observational approach while conducting response actions in the 200 Areas will allow
17 integrating these actions with longer range objectives of final remediation of similar areas
18 and the entire 200 Areas. Site characterization and remediation data will be collected
19 concurrently with the use of LFIs, IRMs, and treatability testing. The knowledge gained
20 through these different activities will be applied to similar areas. The overall goal of this
21 approach is convergence on an appropriate response action as early as possible while
22 continuing to obtain valuable characterization information during remediation phases.

23 24 25 **7.1 PRELIMINARY REMEDIAL ACTION OBJECTIVES**

26
27 The RAOs are remediation goals for protection of human health and the
28 environment that specify the contaminants and media of concern, exposure pathways, and
29 allowable contaminant levels. The RAOs discussed in this section are considered to be
30 preliminary and may change or be refined as new data are acquired and evaluated.

31
32 The fundamental objective of the corrective action process at the Semi-Works
33 Aggregate Area is to protect environmental resources and/or human receptors from the
34 potential threats that may exist because of known or suspected contamination. Specific
35 interim and final RAOs will depend in part on current and reasonable potential future
36 land use in the Semi-Works Aggregate Area and the 200 Areas.

37
38 Potential future land use will affect the risk-based cleanup objectives, potential
39 ARARs, and point of compliance. The RAOs for protecting human health for
40 residential or agricultural land use would be based on risk assessment exposure scenarios
41 requiring cleanup to lower contaminant levels than for recreational or industrial land
42 uses. It is important that potential future land use and the RAOs be clearly defined and

1 agreed upon by the DOE, EPA, and Ecology before further and more detailed
2 evaluation of remedial actions. The Hanford Site Remedial Action Environmental
3 Impact Statement is intended to resolve the land use issues. A ROD for this
4 environmental impact statement is expected in the spring of 1994.

5
6 To focus remedial actions with a bias for action through implementing IRMs,
7 preliminary RAOs are identified for the 200 Areas and Semi-Works Aggregate Area.
8 The overall objective for the 200 Areas is as follows:

9
10 Reduce the risk of harmful effects to the environment and human users of the
11 area by reducing the toxicity, mobility, or volume of contaminants from the source
12 areas to meet ARARs or risk-based levels that will allow industrial use of the area
13 (this is a potential final RAO, and an interim action objective based on current
14 use of the 200 Area).

15
16 The RAOs are further developed in Table 7-1 for media of concern and
17 applicable exposure pathways (see Sections 4.1 and 4.2) for the Semi-Works Aggregate
18 Area. The media of concern for the Semi-Works Aggregate Area include:

- 19
- 20 • Radiation-contaminated soils that could result in direct exposure or inhalation
 - 21
 - 22 • Contaminated soils that are or could contribute to groundwater contamination
 - 23
 - 24 • Vadose zone vapors that could cause ambient air impacts or contribute to the
 - 25 lateral and vertical migration of contaminants in the soil and to the
 - 26 groundwater
 - 27
 - 28 • Biota that could mobilize radionuclides or chemical contaminants and could
 - 29 thereby degrade the integrity of other controls, such as caps.
 - 30

31 Waste materials currently stored in single-shell tanks that contribute or may
32 contribute contaminants to environmental media will not be addressed by this AAMS
33 program but rather by the single-shell tank program. In addition, groundwater as an
34 exposure medium is not addressed in this source AAMS report but will be addressed in
35 the 200 East Groundwater Aggregate Area Management Study Report.

36
37

7.2 PRELIMINARY GENERAL RESPONSE ACTIONS

General response actions represent broad classes of remedial measures that may be appropriate to achieve both interim and final RAOs at the Semi-Works Aggregate Area, and are presented in Table 7-2. The following are the general response actions followed by a brief description for the Semi-Works Aggregate Area:

- No action (applicable to specific facilities)
- Institutional controls
- Waste removal and treatment or disposal
- Waste containment
- In situ waste treatment
- Combinations of the above actions.

No action is included for evaluations as required by the National Environmental Policy Act and National Contingency Plan [40 CFR 300.68 (f)(1)(v)] to provide a baseline for comparison with other response actions. The no action alternative may be appropriate for some facilities and sources of contamination if risk assessments determine acceptable natural resource or human health risks posed by those sources or facilities and no contaminant-specific ARARs were exceeded.

Institutional controls involve the use of physical barriers or access restrictions to reduce or eliminate public exposure to contamination. Considering the nature of the Semi-Works Aggregate Area and the 200 Areas as a whole, institutional controls will likely be an integral component of all interim remedial alternatives. Many access and land use restrictions are currently in place at the Hanford Site and will remain in place during implementation of remedial actions. Institutional controls may also be important for final remedial measures alternatives. The decisions regarding future long-term land use at the 200 Areas will be important in determining whether institutional controls will be a part of the remedial measures alternative, and the type of controls required.

Waste removal and treatment or disposal involves excavation of contamination sources for eventual treatment and/or disposal either on a small- or large-scale basis. One approach being considered for large-scale waste removal is macro-engineering, which is based on high volume excavation using conventional surface mining technologies. Waste removal on a macro-engineering scale would be used over large areas such as groups of waste management units, operable units, or operational areas as a final

1 remedial action. Waste removal on a small scale would be conducted for individual
2 waste management units on a selective basis. Small-scale waste removal could be
3 conducted as either an interim or final remedial action. One potential problem with off-
4 site disposal is the lack of an alternate disposal location that will decrease the potential
5 human exposure over the long time required for many of the contaminants. Waste
6 removal actions may not be needed, or only be required on a small scale, to protect
7 human health or the environment for industrial uses of the 200 Areas.

8
9 Waste treatment involves the use of biological, thermal, physical, or chemical
10 technologies. Typical treatment options include biological land farming, thermal
11 processing, soil washing, and fixation/solidification/stabilization. Some treatment
12 technologies may be pilot tested at the highest priority facilities. Waste treatment could
13 be conducted either as an interim or final action and may be appropriate in meeting
14 RAOs for all potential future land uses.

15
16 Waste containment includes the use of capping technologies (i.e., capping and
17 grouting) to minimize the driving force for downward or lateral migration of
18 contaminants. Capping also provides a radiation exposure barrier and barrier to direct
19 exposure. In addition, these barriers provide long-term stability with relatively low
20 maintenance requirements. Containment actions may be appropriate for either interim
21 or final remedial actions.

22
23 In situ waste treatment includes thermal, chemical, physical, and biological
24 technology types, of which there are several specific process options including in situ
25 vitrification, in situ grouting or stabilization, soil flushing, and in situ biotreatment. The
26 distinguishing feature of in situ treatment technologies is the ability to attain RAOs
27 without removing the wastes. The final waste form generally remains in place. This
28 feature is advantageous when exposure during excavation would be significant or when
29 excavation is technically impractical. In situ treatment can be difficult because the
30 process conditions may not be easily controlled.

31
32 In the next section, specific process options within these technology groups are
33 evaluated.

34 35 36 **7.3 TECHNOLOGY SCREENING**

37
38 In this section, potentially applicable technology types and process options are
39 identified. These process options are then screened using effectiveness, implementability,
40 and relative cost as criteria to eliminate those process options that would not be feasible
41 at the site. The remaining applicable processes are then grouped into remedial
42 alternatives in Sections 7.4.

1 The effectiveness criterion focuses on: (1) the potential effectiveness of process
2 options in handling the areas or volumes of media and meeting the remedial action
3 objectives; (2) the potential impacts to human health and the environment during the
4 construction and implementation phase; and (3) how proven and reliable the process is
5 with respect to the contaminants and conditions at the site. This criterion also
6 concentrates on the ability of a process option to treat a contaminant type (organics,
7 inorganics, metals, radionuclides, etc.) rather than a specific contaminant (nitrate,
8 cyanide, chromium, plutonium, etc.).
9

10 The implementability criterion places greater emphasis on the institutional aspects
11 of implementability, such as the ability to obtain necessary permits for off-site actions, the
12 availability of treatment, storage, and disposal services, and the availability of necessary
13 equipment and skilled workers to implement the technology. It also focuses on the
14 process option's developmental status, whether it is an experimental or established
15 technology.
16

17 The relative cost criterion is an estimate of the overall cost of a process, including
18 capital and operating costs. At this stage in the process, the cost analysis is made on the
19 basis of engineering judgement, and each process is evaluated as to whether costs are
20 high, medium, or low relative to other process options.
21

22 A process option is rated effective if it can handle the amount of area or media
23 required, if it does not impact human health or the environment during the construction
24 and implementation phases, and if it is a proven or reliable process with respect to the
25 contaminants and conditions at the site. Also a process option is considered more
26 effective if it treats a wide range of contaminants rather than a specific contaminant. An
27 example of a very effective process option would be vitrification because it treats
28 inorganics, metals, and radionuclides. On the other hand, chemical reduction may only
29 treat chromium (VI), making it a less useful option.
30

31 An easily implemented process option is one that is an established technology,
32 uses readily available equipment and skilled workers, uses treatment, storage, and
33 disposal services that are readily available, and has few regulatory constraints.
34 Preference is given to technologies that are easily implemented.
35

36 Preference is given to lower cost options, but cost is not an exclusionary criterion.
37 A process option is not eliminated based on cost alone.
38

39 Results of the screening process are shown in Table 7-3. Brief descriptions are
40 given of the process options, followed by comments regarding the evaluation criteria.
41 The last column of the table indicates whether the process option is rejected or carried
42 forward for possible alternative formation. The table first lists technologies that address

1 soil RAOs. Next, technologies pertaining to biota RAOs are presented. All the
2 biota-specific technologies happen to be technologies that were listed for soil RAOs. Air
3 RAOs are dealt with as soil remediation issues because the air contamination is a result
4 of the contaminants in the soil: addressing and remediating the air pathways would be
5 unnecessary and ineffective as long as there is soil contamination. If the soil is
6 remediated, the source of the air contamination would be removed.

7
8 The conclusions column of Table 7-3 indicates that no action, monitoring, 3
9 institutional process options, and 16 other process options are retained for further
10 development of alternatives. Section 7.4 discusses a number of preliminary remedial
11 action alternatives using either one or a combination of several of the technologies
12 retained in Table 7-3.

13 14 15 **7.4 PRELIMINARY REMEDIAL ACTION ALTERNATIVES**

16
17 This section develops and describes several remedial alternatives considered
18 applicable to disposal sites that contain hazardous chemicals, radionuclides, and volatile
19 organic compounds. These alternatives are not intended as recommended actions for
20 any individual site, but are intended only to provide potential options applicable to most
21 sites where multiple contaminants are present. Selection of actual remedial alternatives
22 that should be applied to the individual sites would be partly based on future expedited
23 or interim actions and LFIs, as recommended in Section 9.0 of this report. Selection of
24 proper alternatives would be conducted within the framework of the *Hanford Site Past-*
25 *Practice Strategy* (DOE/RL 1992) and the strategy outlined in Section 9.4.

26
27 The remedial alternatives are developed in Section 7.4.1. Then, in Section 7.4.2
28 through Section 7.4.7, the remedial action alternatives are described. Detailed
29 evaluations and costs are not provided because site-specific conditions must be further
30 investigated before meaningful evaluations could be conducted.

31 32 33 **7.4.1 Development of Remedial Alternatives**

34
35 Potentially feasible remedial technologies were described and evaluated in Section
36 7.3. Some of those technologies have been proven to be effective and constructible at
37 industrial waste sites, while other technologies are in the developmental stages. EPA
38 guidance on feasibility studies for uncontrolled waste management units recommends that
39 a limited number of candidate technologies be grouped into "Remedial Alternatives."
40 For this study, technologies were combined to develop remedial alternatives and provide
41 at least one alternative for each of the following general strategies:
42

Draft A

- No action
- Institutional controls
- Removal, above-ground treatment, and disposal
- Containment
- In situ treatment.

The alternatives are intended to treat all or a major component of the Semi-Works Aggregate Area contaminated waste management units or unplanned releases. Consistent with the development of RAOs and technologies, alternatives were developed based on treating classes of compounds (radionuclides, heavy metals, inorganics, and organics) rather than specific contaminants. At a minimum, the alternative must be a complete package. For example, disposal of radionuclide-contaminated soil must be combined with excavation and backfilling of the excavated site.

One important factor in the development of the preliminary remedial action alternatives is the fact that radionuclides, heavy metals, and some inorganic compounds cannot be destroyed. Rather, these compounds must be physically immobilized, contained, isolated, or chemically converted to less mobile forms to satisfy RAOs. Organic compounds can be destroyed, but may represent a smaller portion of the overall contamination at the Semi-Works Aggregate Area. Both no action and institutional controls are required as part of the CERCLA RI/FS guidance. The purpose of including both of these alternatives is to provide decision-makers with information on the entire range of available remedial actions.

For the containment alternative, an engineered multimedia cover, with or without vertical barriers (depending on the specifics of the remediation) was selected. Two alternatives were selected to represent the excavation and treatment strategy. One of these deals with disposal of transuranic-contaminated soils. Finally, three in situ alternatives were identified. One deals with vapor extraction for volatile organic compounds, one with stabilization of soils, and the other with vitrification of soils.

It is recognized that this does not represent an exhaustive list of all applicable alternatives. However, these do provide a reasonable range of remedial actions that are likely to be evaluated in future feasibility studies. The remedial action alternatives are summarized as follows:

- 1 • No action
- 2
- 3 • Institutional controls
- 4
- 5 • Engineered multimedia cover with or without vertical barriers (containment)
- 6
- 7 • In situ grouting or stabilization of soil (in situ treatment)
- 8
- 9 • Excavation, above-ground treatment, and disposal of soil (removal, treatment
- 10 and disposal)
- 11
- 12 • In situ vitrification of soil (in situ treatment)
- 13
- 14 • Excavation, treatment, and geologic disposal of soil with transuranic
- 15 radionuclides (removal, treatment, and disposal)
- 16
- 17 • In situ soil vapor extraction of volatile organic compounds (in situ treatment).
- 18

19 These alternatives, with the exception of no action and institutional controls, were
20 developed because they satisfy a number of RAOs simultaneously and use technologies
21 that are appropriate for a wide range of contaminant types. For example, constructing
22 an engineered multimedia cover can effectively contain radionuclides, heavy metals,
23 inorganic compounds, and organic compounds simultaneously. It satisfies the RAOs of
24 protecting human health and the environment from exposures from contaminated soil,
25 bio-mobilization, and airborne contaminants. In situ soil vapor extraction is more
26 contaminant-specific than the other alternatives, but it addresses a contaminant class
27 (volatile organic compounds) that is not readily treated using the other options, such as
28 in situ stabilization. It is possible that some waste management units may require a
29 combination of the identified alternatives to completely address all contaminants.

30
31 The use of contaminant-specific remedial technologies was avoided because there
32 appear to be few, if any, waste management units where a single contaminant has been
33 identified. It is possible to construct alternatives that include several contaminant-specific
34 technologies, but the number of combinations of technologies would result in an
35 unmanageable number of alternatives. Moreover, the possible presence of unidentified
36 contaminants may render specific alternatives unusable. Alternatives may be refined as
37 more contamination data are acquired. For now, the alternatives will be directed at
38 remediating the major classes of compounds (radionuclides, heavy metals, inorganics, and
39 organics).

40
41 In all alternatives except the no-action alternative, it is assumed that monitoring
42 and institutional controls are required, although they may be temporary. These features

are not explicitly mentioned, and details are purposely omitted until a more detailed evaluation may be performed in subsequent studies.

In the next sections, the preliminary remedial action alternatives are described in more detail, with the exception of the no-action and institutional control options.

7.4.2 Alternative 1 - Engineered Multimedia Cover with or without Vertical Barriers

Alternative 1 consists of an engineered multimedia cover. Vertical barriers such as grout curtains or slurry walls may be used in conjunction with the cover. Figure 7-2 shows a schematic diagram of an engineered multimedia cover without the vertical barriers. If the affected area includes either a naturally occurring or engineered depression, then imported backfill would be placed to control runoff and run-on water. The engineered cover itself may consist of clay, gravel, sand, asphalt, soil, and/or synthetic liners. A liquid collection layer could also be included. The specific design of the cover and vertical barriers would be the subject of a focused feasibility study which may be supported by performance testing. The barrier would be designed to minimize infiltration of surface water by enhancing the evapotranspiration mechanism. The covered area may be fenced, and warning signs may be posted.

Alternative 1 would provide a permanent cover over the affected area. The cover would accomplish the following: minimize or eliminate the migration of precipitation into the affected soil; reduce the migration of windblown dust that originated from contaminated surface soils; reduce the potential for direct exposure to contaminated soils; and reduce the volatilization of volatile organic compounds and tritium to the atmosphere. If vertical barriers are included, they would limit the amount of lateral migration of contaminants.

7.4.3 Alternative 2 - In Situ Grouting or Stabilization of Soil

Radioactive and hazardous soil would be grouted in this alternative using in situ injection methods to significantly reduce the leachability of hazardous contaminants, radionuclides, and/or volatile organic compounds from the affected soil. Grouting may also be used to fill voids, such as in cribs, thereby reducing subsidence. Another variation of this alternative would be to stabilize the soil using in situ mixing of soil with stabilizing compounds such as pozzolanics or fly ash.

Figure 7-3 shows a schematic diagram of the in situ grout injection process. Grouting wells would be installed and screened throughout the affected vertical zones. Specially formulated cement grout (determined by treatability studies) would be injected

1 and allowed to cure. In situ stabilization would be conducted in a similar manner, except
2 a cutting-head tool would be used to mix the contaminated soil with stabilizing
3 compounds fed into the soil.
4

5 Alternative 2 would provide a combination of immobilization and containment of
6 heavy metal, radionuclide, and inorganic contamination. Thus, this alternative would
7 reduce migration of precipitation into the affected soil; reduce the migration of
8 windblown dust that originated from contaminated surface soils; reduce the potential for
9 direct exposure to contaminated soils; and reduce the volatilization of volatile organic
10 compounds.
11

12 13 7.4.4 Alternative 3 - Excavation, Soil Treatment, and Disposal

14
15 Under Alternative 3, radioactive and hazardous soil would be excavated using
16 conventional techniques, with special precautions to minimize fugitive dust generation.
17 The soil would be treated above ground. Several treatment options could be selected
18 from the physical, chemical, and thermal treatment process options screened in Section
19 7.3. For example, thermal desorption with off gas treatment could be used if organic
20 compounds are present; soil washing could be used to remove contaminated silts and
21 sands or specific compounds; and stabilization could be used to immobilize radionuclides
22 and heavy metals. The specific treatment method would depend on site-specific
23 conditions (determined in part through bench-scale testing). The treated soil would be
24 backfilled into the original excavation or landfilled. Soil treatment by-products may
25 require additional processing or treatment. Figure 7-4 shows a schematic diagram of this
26 alternative.
27

28 Alternative 3 would be effective in treating a full range of contamination,
29 depending on the type of treatment processes selected. Attainment of soil RAOs would
30 depend on the depth to which the soil was excavated. If near-surface soil was treated,
31 airborne contamination, direct exposure to contaminated soil, and bio-mobilization of
32 contamination would be minimized. Because of practical limits on deep excavation, deep
33 contamination may not be removed and would be subject to migration into groundwater.
34 Alternative 3 could be used in conjunction with Alternative 1 (multimedia cap) to reduce
35 this possibility.
36

37 38 7.4.5 Alternative 4 - In Situ Vitrification of Soil

39
40 In this alternative, the contaminated soil in a subject site would be immobilized by
41 in situ vitrification. Figure 7-5 shows a schematic diagram of the alternative. Import fill
42 would initially be placed over the affected area to reduce exposures to the remediation

workers from surface contamination. High power electrodes would be used to vitrify the contaminated soil under the site to a depth below where contamination is present. A large fume hood would be constructed over the site before the start of the vitrification process to collect and treat emissions. After completion of the vitrification, the site would be built back to original grade with imported backfill. Fences and warning signs may be placed around the vitrified monolith to minimize disturbance and potential exposure.

In situ vitrification would be effective in treating radionuclides, heavy metals, and inorganic contamination and may also destroy organic contaminants. This would reduce the potential for exposures by leaching to groundwater, windblown dust and direct dermal contact. However, this alternative would not reduce the mass or toxicity of the radionuclides present on site. Also, in situ vitrification may be limited to depths of less than about 100 feet, which may not be adequate to immobilize deep contamination.

7.4.6 Alternative 5 - Excavation, Above-Ground Treatment, and Geologic Disposal of Soil with Transuranic Radionuclides

Figure 7-6 shows a schematic diagram of Alternative 5. Special excavation procedures would have to be used to minimize fugitive dust. Non-transuranic "overburden" may have to be removed, temporarily stored, and returned to the excavation after the transuranic-contaminated soil was removed. Imported backfill would be used to restore the site to original grade. The excavated transuranic soil would be vitrified or stabilized by an above-ground treatment plant. The vitrified or stabilized soil would then be shipped to a transuranic waste repository. Long-term storage may be required until a suitable facility could be sited and constructed. An engineered multimedia cover (Alternative 1) could be installed over the completed site to reduce exposure to any remaining contaminated, non-transuranic soils.

For Alternative 5, soil containing transuranic radionuclides at concentrations exceeding 100 nCi/g would be excavated, treated, and disposed of. The 100 nCi/g is a significant cleanup standard related to transuranics because it is the cutoff point between low-level (≤ 100 nCi/g) versus waste, which is regulated as transuranic (> 100 nCi/g) as outlined in DOE Order 5820.2A, Radioactive Waste Management (DOE 1988b). Thus, potential exposure to and migration of transuranic wastes would be minimized. Potential exposure to other contaminants would be determined by other remedial alternatives implemented. At sites containing transuranic and non-transuranic wastes, the use of Alternative 5 alone may not satisfy all RAOs.

7.4.7 Alternative 6 - In Situ Soil Vapor Extraction for Volatile Organic Compounds

Figure 7-7 shows a schematic diagram of a representative soil vapor extraction system. The soil vapor extraction system would consist of venting wells, manifold piping, condensed water collectors, HEPA filters, and a catalytic oxidizer. The condensed water may contain volatile organic compounds and radionuclides, so it may have to be disposed of as radioactive mixed waste. The vented air may contain radionuclide-containing dust particles, so HEPA filters would be installed to remove the particulate radionuclides. The vented vapors would be treated by the catalytic incinerator to provide at least 95 percent destruction. Because there are few sites in the Semi-Works Aggregate Area, the potential use of soil vapor extraction in this aggregate area would be limited.

In situ soil vapor extraction is a proven technology for removal of volatile organic compounds from the vadose zone soils. Soil vapor extraction would reduce downward migration of the volatile organic compound vapors through the vadose zone, and thereby minimize potential cross-media migration into the groundwater. Soil vapor extraction would reduce upward migration of volatile organic compounds through the soil column into the atmosphere, and thereby minimize inhalation exposures to the contaminants. In some cases the radionuclides were discharged to the disposal sites with volatile organic compounds (e.g., hexone). Removal of the volatile organic compounds by implementing soil vapor extraction could reduce the mobility of the radionuclides, and thereby reduce the potential for downward migration of the radionuclides. Finally, soil vapor extraction would enhance partitioning of the volatile organic compounds off of the soil and into the vented air stream, resulting in the permanent removal and destruction of the volatile organic compounds. Alternative 6 may be used in conjunction with other alternatives if contaminants other than volatile organic compounds are present. However, because of the limited number of Semi-Works Aggregate Area waste management units that potentially contain volatile organic compounds, the use of soil vapor extraction is unlikely to be extensive.

7.5 PRELIMINARY REMEDIAL ACTION ALTERNATIVES APPLICABLE TO WASTE MANAGEMENT UNITS AND UNPLANNED RELEASE SITES

The purpose of this section is to discuss which preliminary remedial action alternatives could be used to remediate each Semi-Works Aggregate Area waste management unit or unplanned release. The criteria used for deciding this are as follows:

- Installing an engineered multimedia cover with or without vertical barriers (Alternative 1) could be used on any site where contaminants may be leached

or mobilized by surface water infiltration or if surface/near-surface contamination exists.

- In situ grouting or stabilization (Alternative 2) could be used on any waste management unit or unplanned release site that contain heavy metals, radionuclides, and/or other inorganic compounds. In situ grouting could also be effective in filling voids for subsidence control. Suitable sites are underground contaminated waste zones as opposed to surface contamination.
- Excavation and soil treatment (Alternative 3) could be used at most waste management units or unplanned release sites that contain radionuclides, heavy metals, other inorganics compounds, and/or semi-volatile organic compounds. Surface contamination sites were considered suitable with the maximum applicable depth to be determined on a case-by-case basis.
- In situ vitrification (Alternative 4) could be used at most waste management unit or unplanned release sites, although vapor extraction may be needed when volatile organic compounds are present. Waste management units or unplanned release sites where in situ vitrification may not be effective include reverse wells and other sites where the contamination is present in a very narrow geometry, at deep locations, or at surface-only contamination sites.
- Excavation, treatment, and geologic disposal of transuranic-containing soils (Alternative 5) could be used only on those sites that contain transuranic radionuclides. Since a geologic repository is likely to accept only transuranic radioactive soils, non-transuranic radioactive soils will not be remediated using this alternative.
- In situ soil vapor extraction (Alternative 6) could be used on any waste management unit or unplanned release sites that contains volatile organic compounds. Such sites are not common in the Semi-Works Aggregate Area.

Using these criteria, Table 7-4 was created showing possible preliminary remedial action alternatives that could be used to remediate each of the waste management units and unplanned release sites. Table 7-4 excludes units and releases that will be addressed by other programs. For example, the 200 East Powerhouse Ditch is excluded because it will be addressed by the Defense Waste Management Program. Note that a single alternative may not be sufficient to remediate all contamination at a single site. For example, soil vapor extraction to remove organic contaminants could precede in situ vitrification. Also, different combinations of technologies are possible besides those presented in these preliminary alternatives.

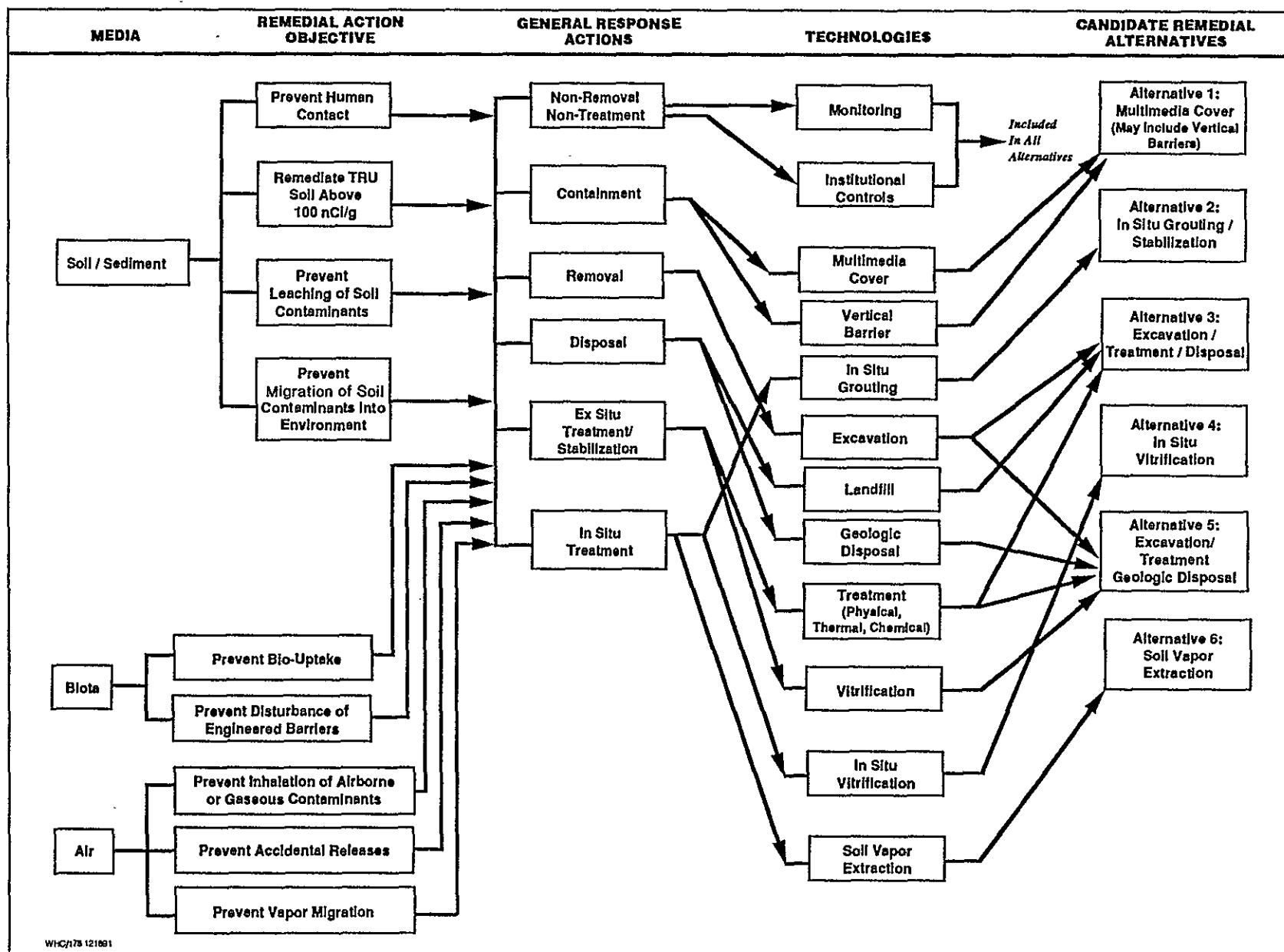
1 Each waste management unit or unplanned release site may require just one
2 alternative or a combination of many alternatives. Furthermore, similar units or releases
3 may be remediated simultaneously. Also more specific waste treatment alternatives
4 could be identified and evaluated as more information is obtained.
5

6 Technology development studies will be needed for the in situ vitrification process,
7 and treatability studies will be needed for the in situ grouting or stabilization process, and
8 for soil treatment processes to make sure that they will effectively remediate the
9 contaminants. Specifically, organic waste mobility may be a problem for in situ
10 vitrification; grouting agents and the resulting reduction of contaminant leachability will
11 need to be determined before in situ grouting can be performed; and appropriate
12 treatment protocols and systems will need to be identified before soil washing can be
13 used. Capping, soil vapor extraction, and disposal options are all proven processes but
14 may require site-specific performance assessment (treatability) studies.
15

16 Focused feasibility studies will be required to evaluate alternative designs for all of
17 the alternatives evaluated, as they relate to the specific waste management unit being
18 remediated. A site-by-site economic evaluation is also required before making a decision.
19 This evaluation will require site-specific information obtained in LFIs and focused
20 feasibility studies.
21

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9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5



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Figure 7-1. Development of Candidate Remedial Alternatives for Semi-Works Aggregate Area.

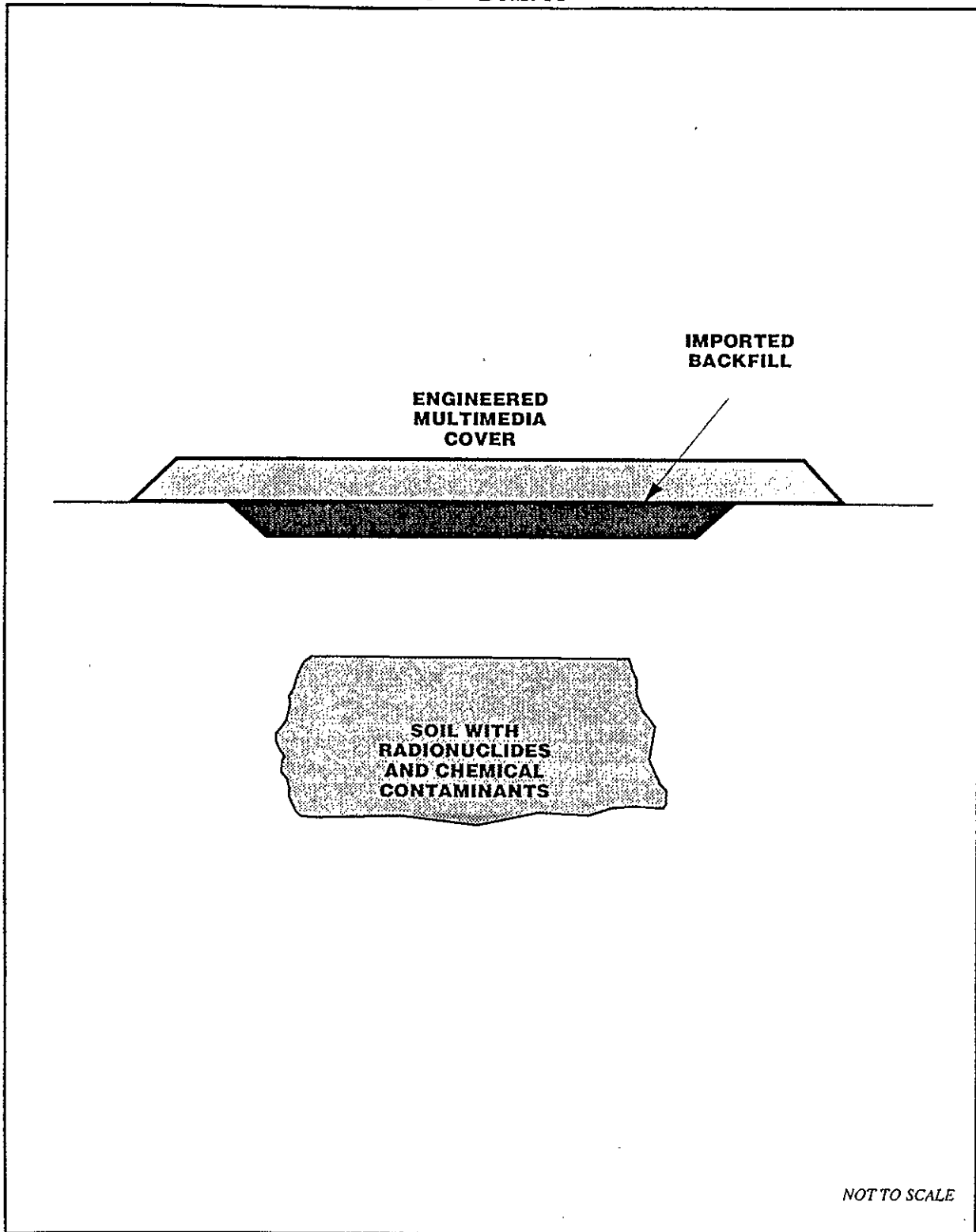


Figure 7-2. Alternative 1 - Multi-Media Cover.

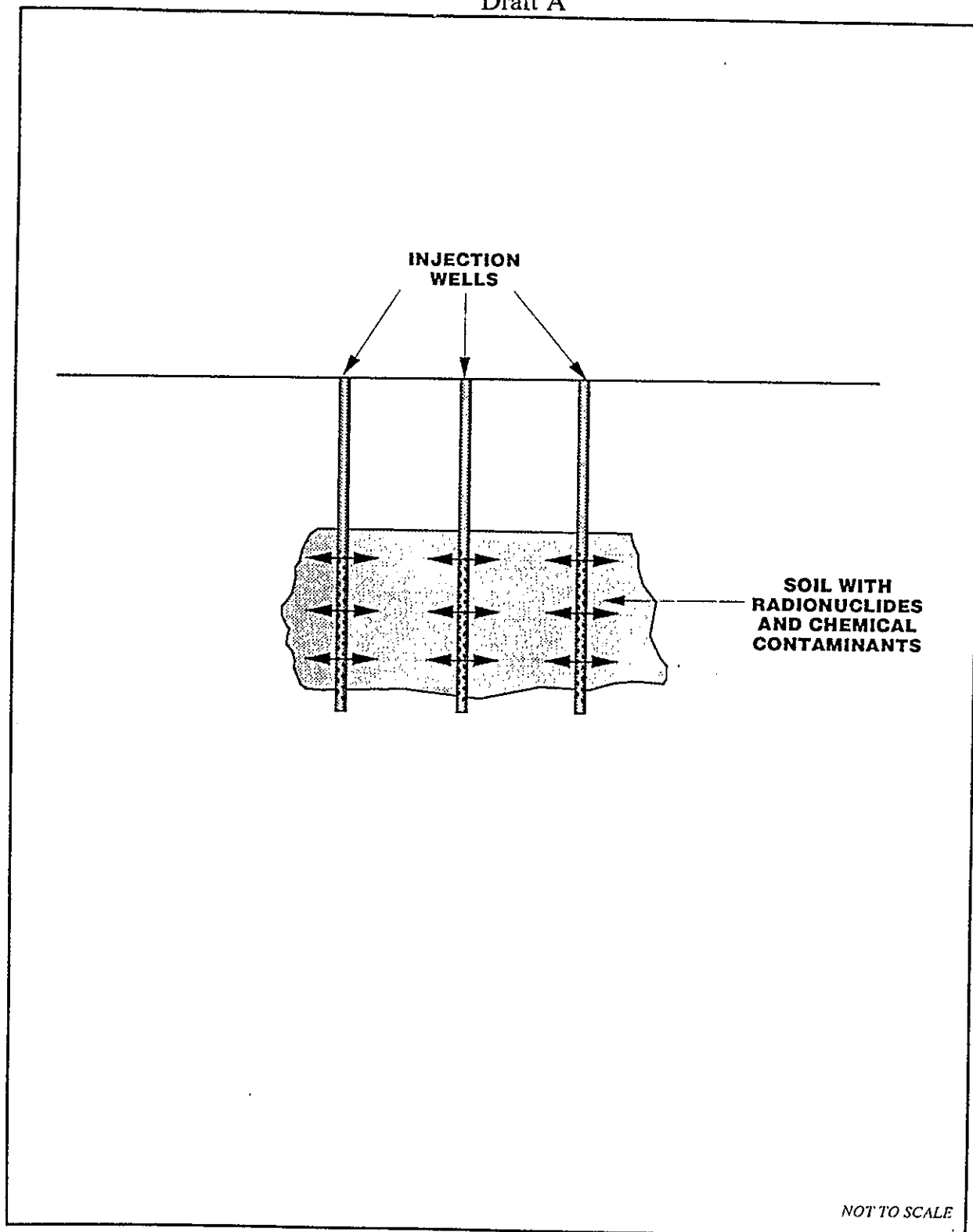
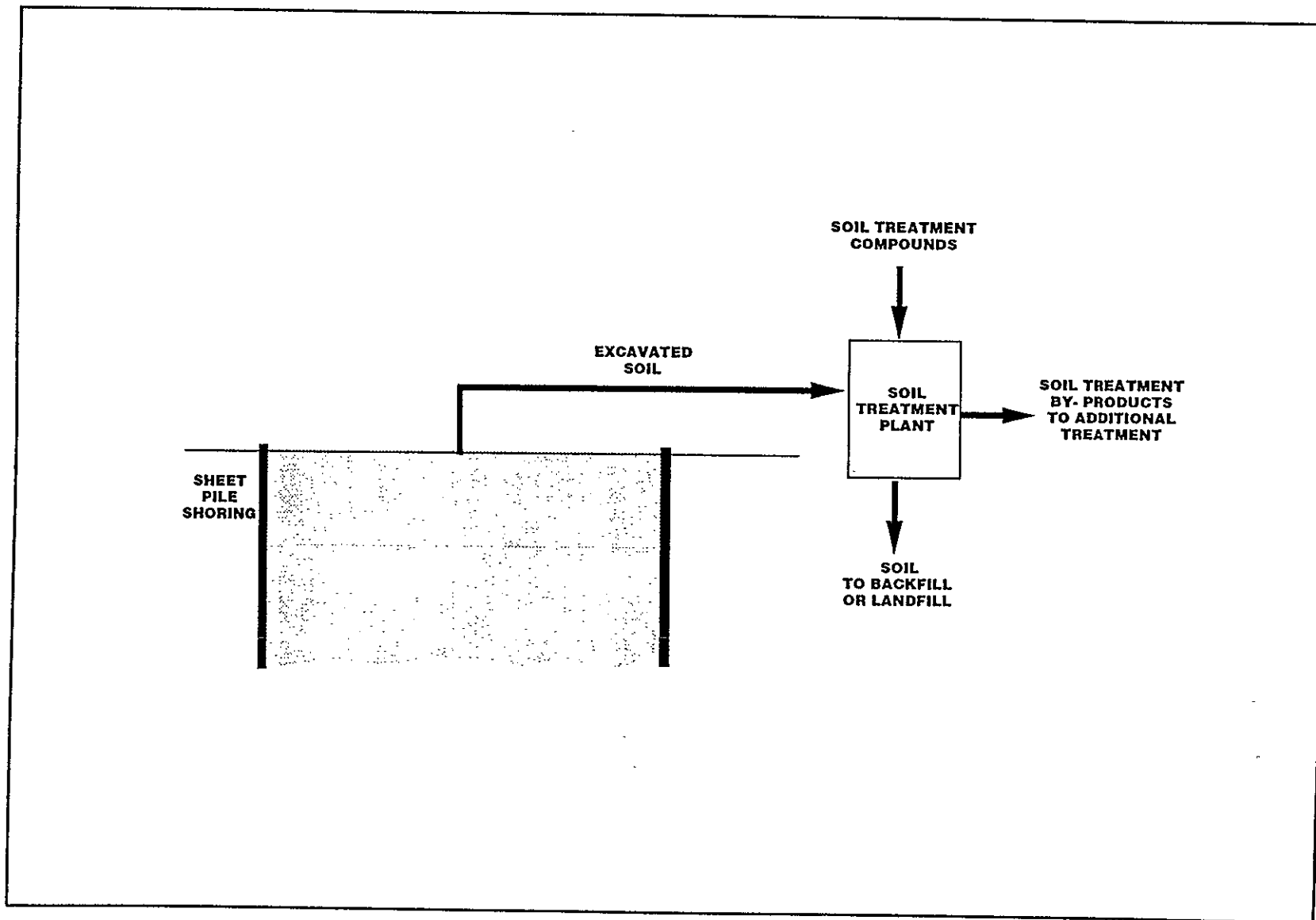


Figure 7-3. Alternative 2 - In Situ Grouting of Soil.



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Figure 7-4. Alternative 3 - Excavation, Treatment, and Disposal.

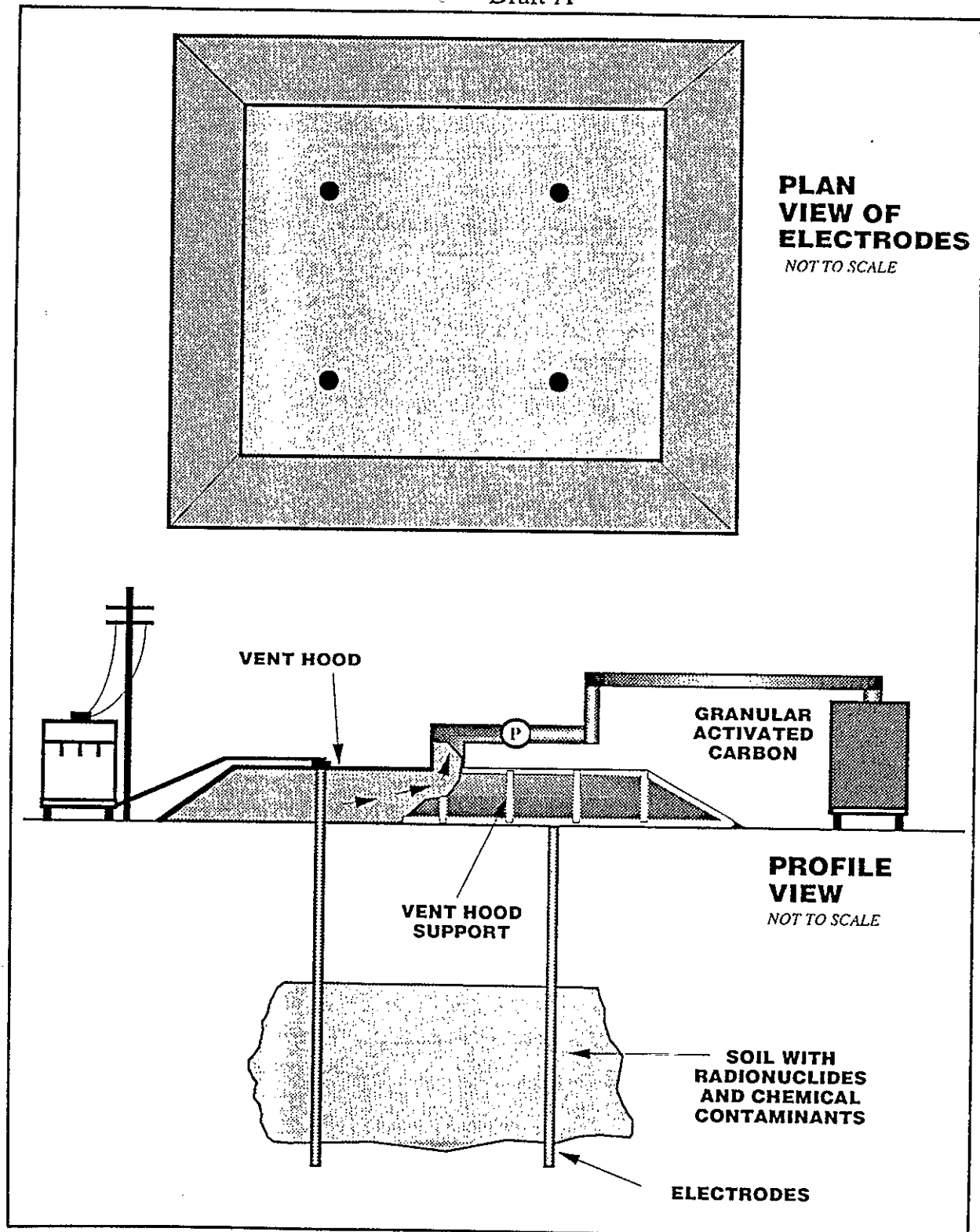


Figure 7-5. Alternative 4 - In Situ Vitrification of Soil.

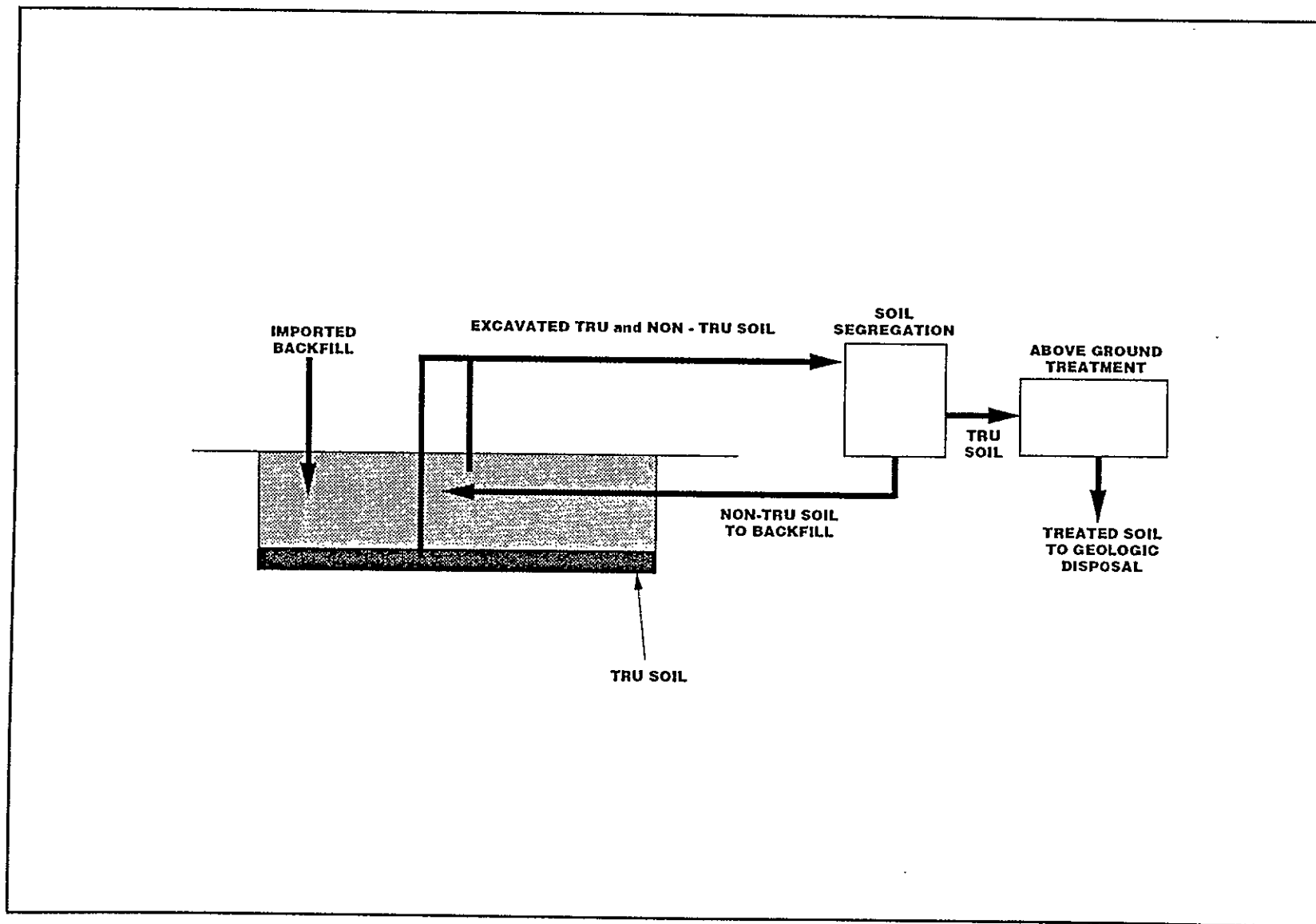
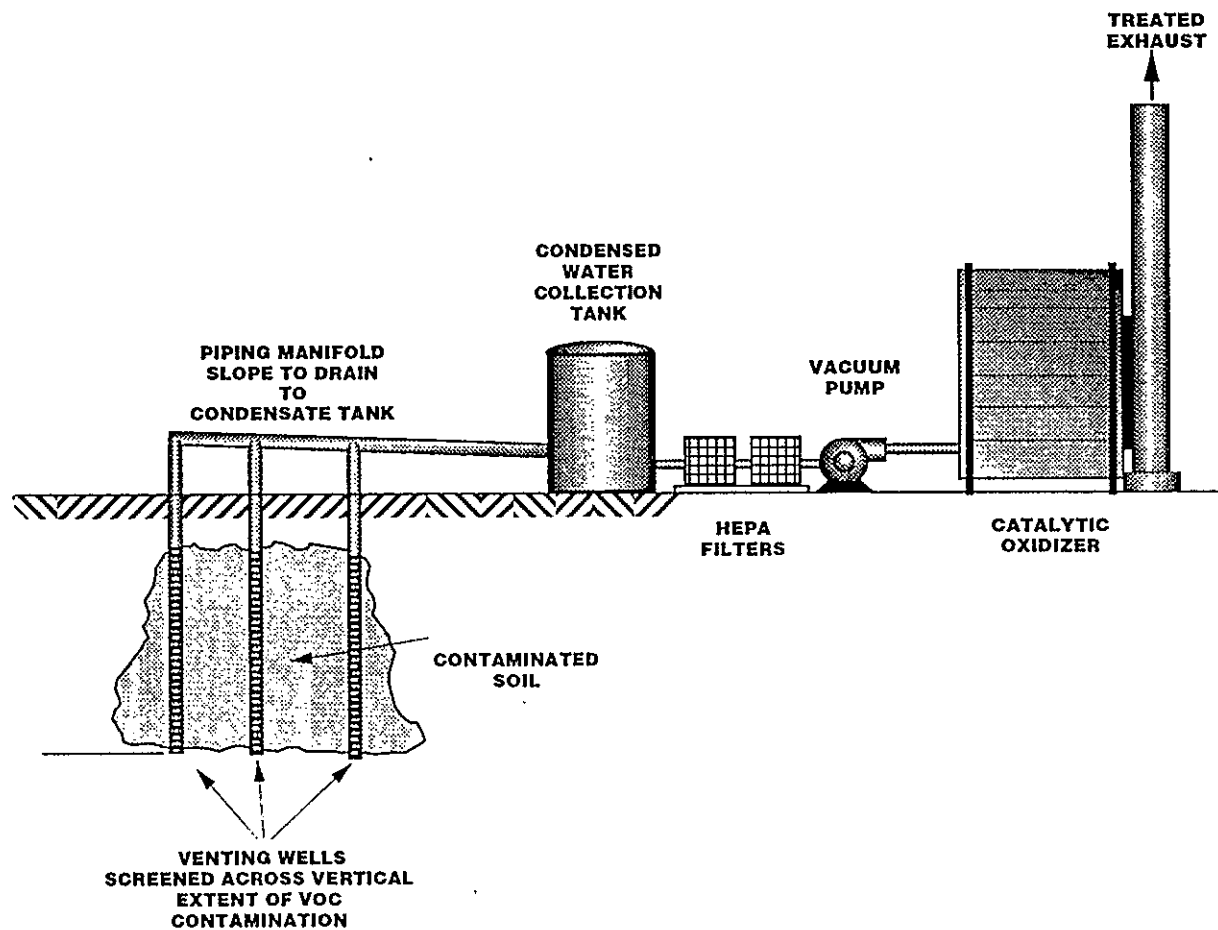


Figure 7-6. Alternative 5 - Excavation, Treatment, and Geologic Disposal of Soil with Transuranic Radionuclides.



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Figure 7-7. Alternative 6 - Soil Vapor Extraction for Volatile Organic Compounds.

Table 7-1. Preliminary Remedial Action Objectives and General Response Actions. (Sheet 1 of 2)

Remedial Action Objectives			
Environmental Media	Human Health	Environmental Protection	General Response Actions
Soils/ Sediments	<ul style="list-style-type: none"> Prevent ingestion, inhalation, or direct contact with solids containing radioactive and/or hazardous constituents present at concentrations above MTCA and DOE standards for industrial sites (or subsequent risk-based standards). Remediate soils containing transuranic contamination above 100 nCi/g in accordance with 40 CFR 191 requirements. Prevent leaching of contaminants from the soil into the groundwater that would cause groundwater concentrations to exceed MTCA and DOE standards at the compliance point location. 	<ul style="list-style-type: none"> Prevent migration of radionuclides and hazardous constituents that would result in groundwater, surface water, air, or biota contamination with constituents at concentrations exceeding ARARs. 	<ul style="list-style-type: none"> No Action Institutional Controls/Monitoring Containment Excavation Treatment Disposal In Situ Treatment
Biota	<ul style="list-style-type: none"> Prevent bio-uptake by plants. Prevent disturbance of engineered barriers by biota. 	<ul style="list-style-type: none"> Prevent bio-uptake of radioactive contaminants. 	<ul style="list-style-type: none"> No Action Institutional Controls/Monitoring Excavation Disposal Containment
Air (1)	<ul style="list-style-type: none"> Prevent inhalation of contaminated airborne particulates and/or volatile emissions exceeding MTCA and DOE limits from soils/sediments. Prevent accidental release from collapse of containment structures. 	<ul style="list-style-type: none"> Prevent adverse environmental impacts on local biota. 	

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Table 7-1. Preliminary Remedial Action Objectives and General Response Actions. (Sheet 2 of 2)

Remedial Action Objectives			
Environmental Media	Human Health	Environmental Protection	General Response Actions
Buried Containers	<ul style="list-style-type: none"> Prevent leakage of liquids from buried containers that would cause groundwater concentrations to exceed MTCA standards at the compliance point location, or which could result in volatilization emissions of leaking chemicals to the atmosphere. 	<ul style="list-style-type: none"> Prevent wind erosion of soil cover material that would expose buried wastes. Prevent wind erosion of contaminated soil that would lead to exposure exceeding MTCA or DCGs. 	<ul style="list-style-type: none"> No Action/Institutional Controls/Monitoring Wind barriers installed Capping Drum Removal Subsurface barriers

Note: (1) No General Response Actions are required for the air because soil remediation will eliminate the air contamination source.

Table 7-2. Preliminary Remedial Action Technologies. (Sheet 1 of 3)

Media	General Response Action	Technology Type	Process Option	Contaminants Treated
Soil	No Action	No Action	No Action	NA
	Institutional Controls	Land Use Restrictions	Deed Restrictions	NA
		Access Controls	Signs/Fences	NA
			Entry Control	NA
		Monitoring	Monitoring	NA
	Containment	Capping	Multi-Media	I,M,R,O
		Vertical Barriers	Slurry Walls	I,M,R,O
			Grout Curtains	I,M,R,O
			Cryogenic Walls	I,M,R,O
		Dust & Vapor Suppression	Membranes/Sealants/ Wind Breaks/Wetting Agents	I,M,R,O
	Excavation	Excavation	Standard Construction Equipment	I,M,R,O
	Treatment	Thermal Treatment	Vitrification	I,M,R,O
			Incineration	O
			Thermal Desorption	O
			Calcination	I,M,R,O
		Chemical Treatment	Chemical Reduction	M

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Table 7-2. Preliminary Remedial Action Technologies. (Sheet 2 of 3)

Media	General Response Action	Technology Type	Process Option	Contaminants Treated
Soil		Physical Treatment	Hydrolysis	I,O
			Soil Washing	I,M,R,O
			Solvent Extraction	O
			Physical Separation	I,M,R,O
			Fixation/Solidification/Stabilization	I,M,R,O
		Biological Treatment	Containerization	I,M,R,O
			Aerobic	O
			Anaerobic	O
	Disposal	Landfill Disposal	Landfill Disposal	I,M,R,O
		Geologic Repository	Geologic Repository	R (I,M,O if mixed with R)
	In Situ Treatment	Thermal Treatment	Vitrification	I,M,R,O
			Thermal Desorption	O
		Chemical Treatment	Reduction	M,O
		Physical Treatment	Soil Flushing	I,M,R,O
			Vapor Extraction	O
			Grouting	I,M,R

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Table 7-2. Preliminary Remedial Action Technologies. (Sheet 3 of 3)

Media	General Response Action	Technology Type	Process Option	Contaminants Treated
Soil			Fixation/Solidification/ Stabilization	I,M,R,O
		Biological Treatment	Aerobic	O
			Anaerobic	O
Biota	No Action	No Action	No Action	NA
	Institutional Controls	Land Use Restrictions	Deed Restrictions	NA
		Access Controls	Signs/Fences	NA
		Monitoring	Monitoring	NA
	Excavation	Excavation	Standard Construction Equipment	I,M,R,O
	Disposal	Landfill Disposal	Landfill Disposal	I,M,R,O
	Containment	Capping	Multi-Media	I,M,R,O

I = Other Inorganics contaminants applicability
 M = Heavy Metals contaminants applicability
 R = Radionuclide contaminants applicability
 O = Organic contaminants applicability
 NA = Not Applicable

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Table 7-3. Screening of Process Options. (Sheet 1 of 10)

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
SOIL TECHNOLOGIES:						
No Action	No Action	Do nothing to cleanup the contamination or reduce the exposure pathways.	Not effective in reducing the contamination or exposure pathways.	Easily implemented, but might not be acceptable to regulatory agencies, local governments, and the public.	Low	Retained as a "baseline" case.
Land Use Restrictions	Deed Restrictions	Identify contaminated areas and prohibit certain land uses such as farming.	Depends on continued implementation. Does not reduce contamination.	Administrative decision is easily implemented.	Low	Retained to be used in conjunction with other process options.
Access Controls	Signs/Fences	Install a fence and signs around areas of soil contamination.	Effective if the fence and signs are maintained.	Easily implemented. Restrictions on future land use.	Low	Retained to be used in conjunction with other process options.
	Entry Control	Install a guard/monitoring system to prevent people from becoming exposed.	Very effective in keeping people out of the contaminated areas.	Equipment and personnel easily implemented and readily available.	Low	Retained to be used in conjunction with other process options.
Monitoring	Monitoring	Analyze soil and soil gas samples for contaminants and scan with radiation detectors.	Does not reduce the contamination, but is very effective in tracking the contaminant levels.	Easily implemented. Standard technology.	Low	Retained to be used in conjunction with other process options.
Capping	Multi-Media	Fine soil over synthetic membrane or other layers and covered with soil; applied over contaminated areas.	Effective on all types of contaminants, not likely to crack. Likely to hold up over time.	Easily implemented. Restrictions on future land use will be necessary.	Medium	Retained because of potential effectiveness and implementability.
Vertical Barriers	Slurry Walls	Trench around areas of contamination is filled with a soil (or cement) bentonite slurry.	Effective in blocking lateral movement of all types of soil contamination. May not be effective for deep contamination.	Commonly used practice and easily implemented with standard earth moving equipment. May not be possible for deep contamination.	Medium	Retained for shallow contamination.

Table 7-3. Screening of Process Options. (Sheet 2 of 10)

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
	Grout Curtains	Pressure injection of grout in a regular pattern of drilled holes.	Effective in blocking lateral movement of all types of soil contamination.	Commonly used practice and easily implementable, but depends on soil type. May be difficult to ensure continuous wall.	Medium	Retained because of potential effectiveness and implementability.
	Cryogenic Walls	Circulate refrigerant in pipes surrounding the contaminated site to create a frozen curtain with the pond water.	Effective in blocking lateral movement of all types of soil contamination.	Specialized engineering design required. Requires ongoing freezing.	Medium	Rejected because it is difficult to implement.
Dust and Vapor Suppression	Membranes/ Sealants/Wind Breaks/Wetting Agents	Using membranes, sealants, wind breaks, or wetting agents on top of the contaminated soil to keep the contaminants from becoming airborne.	Effective in blocking the airborne pathways of all the soil contaminants, but may require regular upkeep.	Commonly used practice and very easy to implement, but land restrictions will be necessary.	Low	Rejected because of limited duration of integrity and protection.
Excavation	Standard Excavating Equipment	Moving soil around the site and loading soil onto process system equipment.	Effective in moving and transporting soil to vehicles for transportation, and for grading the surface.	Equipment and workers are readily available.	Low	Retained because of potential effectiveness and implementability.
Thermal Treatment	Vitrification	Convert soil to glassy materials by application of electric current.	Effective in destroying organics and immobilizing the inorganics and radionuclides. Off-gas treatment for volatiles may be required.	Implementable. Commercial units are available. Laboratory testing required to determine additives, operating conditions, and off gas treatment. Must pre-treat soil to reduce size of large materials.	High	Retained because of potential ability to immobilize radionuclides and destroy organics.

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Table 7-3. Screening of Process Options. (Sheet 3 of 10)

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
	Incineration	Destroy organics by combustion in a fluidized bed, kiln, etc.	Effectively destroys the organic soil contaminants. Some heavy metals will volatilize. Radionuclides will not be treated.	Implementable. Technology is well developed. Mobile units are available for relatively small soil quantities. Off-site treatment is available. Air emissions and wastewater generation should be addressed.	High	Rejected because of potential air emissions and wastewater generation and low organic content of soils.
	Thermal Desorption	Organic volatilization at 150 to 400°C (300 to 800°F) by heating contaminated soil followed by off gas treatment.	Effectively destroys the organic soil contaminants. Heavy metals less likely to volatilize than in high temperature treatments. Radionuclides will not be treated.	Potentially implementable. Successfully demonstrated on a pilot-scale level. Full-scale remediation yet to be demonstrated. Pilot testing essential.	Medium	Retained because of potential effectiveness and implementability.
	Calcination	High temperature decomposition of solids into separate solid and gaseous components without air contact.	Effective in the decomposition of inorganics such as hydroxides, carbonates, nitrates, sulfates, and sulfites. Removes organic components but does not combust them because of the absence of air. Radionuclides will not be treated.	Commercially available. Most often used for concentration and volume reduction of liquid or aqueous waste. Off-gas treatment is required.	High	Rejected because of limited effectiveness on non-liquid or aqueous wastes.

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Table 7-3. Screening of Process Options. (Sheet 4 of 10)

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
Chemical Treatment	Chemical Reduction	Treat soils with a reducing agent to convert contaminants to a more stable or less toxic form.	May be effective in treating heavy metal soil contaminants. Radioactivity will not be reduced.	Difficult to implement. Virtually untested on treating soils. Competing reactions may reduce efficiency.	Medium	Rejected because of limited applicability and implementation problems.
	Hydrolysis	Acid- or base-catalyst reaction in water to break down contaminants to less toxic components.	Very effective on compounds generally classified as reactive. Limited effectiveness on stable compounds. Radioactivity will not be reduced.	Difficult to implement. Common industrial process. Use for treatment of soils not well demonstrated.	Medium	Rejected because of limited effectiveness and unproven for soils.
Physical Treatment	Soil Washing	Leaching of waste constituents from contaminated soil using a washing solution.	Effectiveness is contaminant specific. Generally more effective on contaminants that partition to the fine soil fraction. Radioactivity will not be reduced.	Implementable. Treatability tests are necessary. Well developed technology and commercially available.	Medium	Retained because of potential effectiveness and implementability.
	Solvent Extraction	Contacting a solvent with contaminated soils to preferentially dissolve the contaminants into the solvent.	The selected solvent is often just as hazardous as the contaminants present in the waste. May lead to further contamination. Radioactivity will not be reduced.	Implementable. Laboratory testing necessary to determine appropriate solvent and operating conditions.	Medium	Rejected because the solvent may lead to further contamination.

Table 7-3. Screening of Process Options. (Sheet 5 of 10)

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
Biological Treatment	Physical Separation	Separating soil into size fractions.	Effective as a concentration process for all contaminants that partition to a specific soil size fraction.	Implementable. Most often used as a pretreatment to be combined with another technology. Equipment is readily available.	Low	Retained because of potential effectiveness and implementability.
	Fixation/Solidification/Stabilization	Form low permeability solid matrix by mixing soil with cement, asphalt, or polymeric materials.	Effective in reducing inorganic and radionuclide mobility. Effectiveness for organic stabilization is highly dependent on the binding agent.	Implementable. Stabilization has been implemented for site remediations. Treatability studies are needed. Volume of waste is increased.	Medium	Retained because of potential effectiveness and implementability.
	Containerization	Enclosing a volume of waste within an inert jacket or container.	Effective for difficult to stabilize, extremely hazardous, or reactive waste. Reduces the mobility of radionuclides.	May be implementable for low concentration waste. Disposal or safe storage of containers required. Regulatory constraints may prevent disposal of containers with certain waste types.	Low	Retained because of potential effectiveness and implementability.
	Acrobic	Microbial degradation in an oxygen-rich environment.	Effectiveness is very contaminant- and concentration-specific. Treatment has been demonstrated on a variety of organic compounds. Not effective on inorganics or radionuclides.	Potentially implementable. Various options are commercially available to produce contaminant degradation. Treatability tests are required to determine site-specific conditions.	Medium	Rejected because of limited applicability and difficult implementation.

Table 7-3. Screening of Process Options. (Sheet 6 of 10)

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
Disposal	Anaerobic	Microbial degradation in an oxygen deficient environment.	Effectiveness is contaminant- and concentration-specific. Treatment has been demonstrated on a variety of organic compounds. Not effective on inorganics or radionuclides.	Potentially implementable. Various options are commercially available to produce contaminant degradation. Treatability tests are required to determine site-specific conditions.	Medium	Rejected because of limited applicability and difficult implementation.
	Landfill Disposal	Place contaminated soil in an existing on-site landfill.	Does not reduce the soil contamination but places all forms of contamination to a more secure place.	Easily implemented if sufficient storage is available in an on-site landfill area.	Medium	Retained because of potential effectiveness and implementability.
	Geologic Repository	Put the contaminated soil in a safe geologic repository.	Does not reduce the soil contamination, but is a very effective long-term method of storing radionuclides. Probably unnecessary for nonradioactive waste.	Difficult to implement because of limited site availability, and permits for transporting radioactive wastes are hard to get.	High	Retained because of effectiveness on transuranic wastes.

Table 7-3. Screening of Process Options. (Sheet 7 of 10)

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
In Situ Thermal Treatment	Vitrification	Electrodes are inserted into the soil and a carbon/glass frit is placed between the electrodes to act as a starter path for initial melt to take place.	Effective in immobilizing radionuclides and most inorganics. Effectively destroys some organics through pyrolysis. Some volatilization of organics and inorganics may occur.	Potentially implementable. Implementability depends on site configuration, e.g., lateral and vertical extent of contamination. Treatability studies required.	High	Retained because of potential ability to immobilize radionuclides and destroy organics.
	Thermal Desorption	Soil is heated in situ by radio-frequency electrodes or other means of heating to temperatures in the 80 to 400°C (200 to 750°F) range thereby causing desorption of volatile and semivolatile organics from the soil.	Effective for removal of volatile and semi-volatile organics from soil. Ineffective for most inorganics and radionuclides. Contaminants are transferred from soil to air.	Implementable for shallow organics contamination. Not implementable for radionuclides and inorganics. Emission treatment and treatability studies required.	Medium	Rejected because of limited applicability.
In Situ Chemical Treatment	Chemical Reduction	Reducing agent is added to the soil to change oxidation state of target contaminant.	Effective for certain inorganics, e.g., chromium. Ineffective for organics. Limited applicability.	Difficult to implement in situ because of distribution requirements for reducing agent.	Low	Rejected because of limited applicability and implementation problems.

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Table 7-3. Screening of Process Options. (Sheet 8 of 10)

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
In Situ Physical Treatment	Soil Flushing	Solutions are injected through injection system to flush and extract contaminants.	Potentially effective for all contaminants. Effectiveness depends on chemical additives and hydrogeology. Flushing solutions posing environmental threat likely to be needed. Difficult recovery of flushing solution.	Difficult to implement. Not implementable for complex mixtures of contaminants. Flushing solution difficult to recover. Chemical additives likely to pose environmental threat.	Medium	Rejected because of implementation problems.
	Vapor Extraction	Vacuum is applied by use of wells inducing a pressure gradient that causes volatiles to flow through air spaces between soil particles to the extraction wells.	Effective for volatile organics. Ineffective for inorganics and radionuclides. Emission treatment required.	Easily implementable for proper site conditions. Requires emission treatment for organics and capture system for radionuclides and volatilized metals.	Medium	Retained for potential application to volatile organics.
	Grouting	Involves drilling and injection of grout to form barrier or injection to fill voids.	Effective in limiting migration of leachate, but difficult to maintain barrier integrity. Potentially effective in filling voids.	Implementable as barrier and for filling voids. Implementability depends on site conditions.	Medium	Retained because of ability to limit contaminant migration and potential use for filling void spaces.
	Fixation/ Solidification/ Stabilization	Solidification agent is applied to soil by mixing in place.	Effective for inorganics and radionuclides. Potentially effective for organics. Effectiveness depends on site conditions and additives used.	Implementable. Treatability studies required to select proper additives. Thorough characterization of subsurface conditions and continuous monitoring required.	Medium	Retained because of potential effectiveness and implementability.

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Table 7-3. Screening of Process Options. (Sheet 9 of 10)

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
In Situ Biological Treatment	Aerobic	Microbial growth utilizing organic contaminants as substrate is enhanced by injection of or spraying with oxygen source and nutrients.	Effective for most organics under proper conditions. Ineffective for inorganics and radionuclides.	Difficult to implement. Treatability studies and thorough subsurface characterization required.	Low	Rejected because of limited applicability and difficult implementation.
	Anaerobic	Microbial growth utilizing organic contaminants as substrate is enhanced by addition of nutrients.	Effective for some volatile and complex organics. Not effective for inorganics and radionuclides.	Difficult to implement. Anoxic ground conditions required. Treatability studies and thorough subsurface characterization necessary.	Low	Rejected because of limited applicability and difficult implementation.
BIOTA TECHNOLOGIES:						
No Action	No Action	Do nothing to cleanup the contamination or reduce the exposure pathways.	Not effective in reducing the contamination or exposure pathways.	Easily implemented, but might not be acceptable to regulatory agencies, local governments, and the public.	Low	Retained as a "baseline" case.
Land Use Restrictions	Deed Restrictions	Identify contaminated areas and prohibit certain land uses such as agriculture.	Ineffective if entered. Does not reduce contamination.	Administrative decision is easily implemented.	Low	Retained to be used in conjunction with other process options.
Access Controls	Signs/Fences	Install a fence and signs around areas of contamination to keep people out and the biota in.	Effective in limiting access if fencing is maintained.	Easily implemented. Restrictions on future land use.	Low	Retained to be used in conjunction with other process options.
	Entry Control	Install a guard/monitoring system to eliminate people from coming in contact with the contamination.	Very effective in keeping people out of the contaminated areas.	Easily implemented equipment and personnel and readily available.	Low	Retained to be used in conjunction with other process options.
Monitoring	Monitoring	Biota sampling and testing for contaminants.	Does not reduce the contamination, but is very effective tracking the contaminant levels.	Easily implemented. Standard technology.	Low	Retained to be used in conjunction with other process options.

Table 7-3. Screening of Process Options. (Sheet 10 of 10)

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
Capping	Multi-Media	Fine soil over synthetic membrane or other layers and covered with soil; applied over contaminated areas.	Effective in reducing the uptake of contaminants, not likely to crack. Likely to hold up over time.	Easily implemented. Restrictions on future land use will also be necessary.	Medium	Retained because of potential effectiveness and implementability.
Excavation	Standard Excavating Equipment	Remove affected biota and load it onto process system equipment.	Effective in moving and transporting biota.	Easily implemented. Equipment and workers are readily available.	Low	Retained because of potential effectiveness and implementability.
Disposal	Landfill Disposal	Place contaminated biota in an existing landfill.	Does not reduce the biota contamination but moves all of the contamination to a more secure place.	Easily implemented if sufficient storage is available in landfill.	Medium	Retained because of potential effectiveness and implementability.

Table 7-4. Preliminary Remedial Action Alternatives Applicable to Waste Management Units and Unplanned Release Sites. (Sheet 1 of 2)

Waste Management Unit or Unplanned Release	Alt 1. Multimedia Cover With or Without Vertical Barriers	Alt 2. In Situ Grouting	Alt 3. Excavation and Treatment	Alt 4. In Situ Vitrification	Alt 5. Excavation, Treatment, and Geologic Disp. of Transuranic Soil	Alt 6. In Situ Soil Vapor Extraction for Volatile Organic Compounds
Plants, Buildings, and Storage Areas						
201-C Process Building	•		•		•	
291-C Ventilation System	•		•		•	
Tanks and Vaults						
241-CX-70 Storage Tank	•					
241-CX-71 Storage Tank	•		•			
241-CX-72 Storage Tank	•					
Cribs and Drains						
216-C-1 Crib	•	•	•	•	•	•
216-C-3 Crib	•	•	•	•	•	•
216-C-4 Crib	•	•	•	•		
216-C-5 Crib	•	•	•	•	•	•
216-C-6 Crib	•	•	•	•	•	•
216-C-7 Crib (2)	•	•	•	•		•
216-C-10 Crib	•	•	•	•	•	•
Critical Mass Laboratory Dry Well North	•	•	•	•		
Critical Mass Laboratory Dry Well South	•	•	•	•		
Critical Mass Laboratory Dry Well East	•	•	•	•		
Gatehouse French Drain	•	•	•	•		
Reverse Wells						
216-C-2 Reverse Well	•	•			•	

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Table 7-4. Preliminary Remedial Action Alternatives Applicable to Waste Management Units and Unplanned Release Sites. (Sheet 2 of 2)

Waste Management Unit or Unplanned Release	Alt 1. Multimedia Cover With or Without Vertical Barriers	Alt 2. In Situ Grouting	Alt 3. Excavation and Treatment	Alt 4. In Situ Vitrification	Alt 5. Excavation, Treatment, and Geologic Disp. of Transuranic Soil	Alt 6. In Situ Soil Vapor Extraction for Volatile Organic Compounds
Ponds, Ditches, and Trenches						
216-C-9 Pond (2)	•	•	•	•	•	•
200 East Powerhouse Ditch (2)	•	•	•	•		
Septic Tanks and Associated Drain Fields						
2607-E-5 Septic Tank and Drain Field (2)	•	•	•	•		
2607-E-7A Septic Tank and Drain Field (2)	•	•	•	•		
Transfer Facilities, Diversion Boxes, and Pipelines						
Semi-Works Valve Pit (1)	•	•	•	•		
Critical Mass Laboratory Valve Pit (1)	•	•	•	•		
241-C-154 Diversion Box (1)	•	•	•	•		
Burial Sites						
218-C-9 Burial Ground	•	•	•	•	•	
Unplanned Releases						
UN-200-E-36	•	•	•	•	•	
UN-200-E-37	•	•	•	•	•	
UN-200-E-98	•	•	•	•		
UN-200-E-141						
241-C Waste Line Unplanned Release No. 1	•	•	•	•	•	
241-C Waste Line Unplanned Release No. 2	•	•	•	•	•	

- Notes: (1) This waste site is not included in the Tri-Party Agreement (Ecology et al., 1991)
 (2) This is an active unit.
 (3) Records indicate that all environmental contamination resulting from this unplanned release was removed and disposed of. Therefore, no applicable alternative(s) was identified.

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8.0 DATA QUALITY OBJECTIVES

As described in Section 1.2.2, the AAMS process, as part of the *Hanford Site Past-Practice Strategy* (DOE/RL 1992), is designed to focus the RI/FS process toward comprehensive cleanup or closure of all contaminated areas at the earliest possible date and in the most effective manner. The fundamental principle of the *Hanford Site Past-Practice Strategy* is a "bias for action" which emphasizes the maximum use of existing data to expedite the RI/FS process as well as allow decisions about work that can be done at the site early in the process, such as ERAs, IRMs, LFIs, and focused feasibility studies (FFSs). The data have already been described in previous sections (2.0, 3.0, and 4.0). Remediation alternatives are described in Section 7.0. However, data, whether existing or newly acquired, can only be used for these purposes if it meets the requirements of data quality as defined by the DQO process developed by the EPA for use at CERCLA sites (EPA 1987). This section implements the DQO process for this, the scoping phase in the Semi-Works Aggregate Area.

In the guidance document for DQO development (EPA 1987), the process is described as involving three stages which have been used in the organization of the following sections:

- Stage 1—Identify decision types (Section 8.1)
- Stage 2—Identify data uses and needs (Section 8.2)
- Stage 3—Design a data collection program (Section 8.3).

8.1 DECISION TYPES (STAGE 1)

Stage 1 of the DQO process is undertaken to identify:

- The decision-makers (thus data users) relying on the data to be developed (Section 8.1.1)
- The data available to make these decisions (Section 8.1.2)
- The quality of these available data (Section 8.1.3)

- The conceptual model into which these data must be incorporated (Section 8.1.4)
- The objectives and decisions that must evolve from the data (Section 8.1.5).

These issues serve to define, from various points of view, the types of decisions that will be made on the basis of the Semi-Works AAMS.

8.1.1 Data Users

The data users for the Semi-Works AAMS, and subsequent investigations such as LFIs, RI/FSs, and RFIs, are the following:

- The decision makers for policies and strategies on remedial action at the Hanford Site. These are the signatories of the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) (Ecology et al. 1990) including the DOE, EPA, and Ecology.

Nominally these responsibilities are assigned to the heads of these agencies, including the Secretary of Energy for DOE, the Administrator of EPA, and the Director of Ecology; although the political process requires that more local policy-makers, such as the Regional Administrator of EPA and the head of the DOE-RL and, to a great extent, technical and policy-assessment staff of these agencies will have a major say in the decisions to be evolved through this process:

- Unit managers of Westinghouse Hanford and potentially other Hanford Site contractors who will be tasked with implementing remedial activities at the Semi-Works Aggregate Area. Staff of these contractors will have to make the lower level (tactical) decisions about appropriate scheduling of activities and allocation of resources (funding, personnel, and equipment) to accomplish the recommendations of the AAMS.
- Concerned members of the wide community involved with the Hanford Site. These may include:
 - Other state (Washington, Oregon, and other states) and federal agencies
 - Affected Indian tribes
 - Special interest groups
 - The general public.

1 These groups will be involved in the decision process through the implementation
2 of the Community Relations Plan (Ecology et al. 1989), and will apply their concerns
3 through the "primary" data users, the signatories of the Tri-Party Agreement.

4
5 The needs of these users will have a pivotal role in issues of data quality. Some of
6 this influence is already imposed by the guidance of the Tri-Party Agreement.

7 8 9 **8.1.2 Available Information**

10
11 The *Hanford Site Past-Practice Strategy* specifies a "bias for action" that intends to
12 make the maximum use of existing data on an initial basis for decisions about
13 remediation. This emphasis can only be implemented if the existing data are adequate
14 for the purpose.

15
16 Available data for the Semi-Works Aggregate Area are presented in Sections 2.0,
17 3.0, and 4.0 and in Topical Reports prepared for this study. As described in Section
18 1.2.2, these data should address several issues:

- 19
20 • Issue 1: Facility and process descriptions and operational histories for
21 waste sources (Sections 2.2, 2.3, and 2.4)
- 22
23 • Issue 2: Waste disposal records defining dates of disposal, waste types, and
24 waste quantities (Section 2.4)
- 25
26 • Issue 3: Sampling events of waste effluents and affected media (Section
27 4.1)
- 28
29 • Issue 4: Site conditions including the site physiography, topography,
30 geology, hydrology, meteorology, ecology, demography, and archaeology
31 (Section 3.0)
- 32
33 • Issue 5: Environmental monitoring data for affected media including air,
34 surface water, sediment, soil, groundwater, and biota (Section 4.1, except
35 that groundwater data are presented in the separate 200 East Area
36 Groundwater AAMS Report).

37
38 A major requirement for adequate characterization of many of these issues is
39 identification of chemical and radiological constituents associated with the sites, with a
40 view to determining the contaminants of concern and the extent of their distribution in
41 the soils beneath each of the waste management units and unplanned releases. There
42 was found to be a limited amount of data useful for this purpose. The data reported for

the various waste management units and unplanned releases in the Semi-Works Aggregate Area (see Section 4.1 and Tables 4-1, 4-2, and 4-3) have been found to describe:

- Inventory—generally estimated from chemical process data and emphasizing radionuclides (Issues 1 and 2). These data are especially limited regarding early activities, and even the most recent data are based on very few sampling events, possibly non-representative of the long-term activity of the waste management units.
- Surface radiological surveys—undifferentiated radiation levels, without identification of the specific radionuclides present and reported in terms of dose rates and maximal contaminant levels (Issue 5). For some of the units only historical radiation surveys are available. These historical data are extremely difficult to relate to the present-day distribution and nature of the radioactive contamination because of the lack of radionuclide identification, the impact of radionuclide decay, and the likelihood that changes have occurred (at least to surface soils) since the time of the surveys.
- External radiation monitoring—similar to the surface radiological surveys but provide even less information because with a fixed-point TLD no spatial distribution is provided. The TLDs are placed at points not associated with specific waste management units.
- Waste, soil, or sediment sampling—these include waste sampling in tanks (in the 241-CX-70 241-CX-71, and 241-CX-72 Storage Tanks), a sediment sample from the 216-C-2 Reverse Well, and waste stream-specific sampling for discharges to the 241-C-7 Crib and the 200 East Powerhouse Ditch. The waste characterization for the 241-CX-71 and 241-CX-72 Storage Tanks is limited to liquids present (no sludge samples were obtained) and only pH and total gamma radiation were measured, with little or no speciation of radionuclides reported. The data reported for the 216-C-7 Crib, the 200 East Powerhouse Ditch, and 241-CX-70 Storage Tank are usable for the purpose of characterizing contaminants likely to be present but do not provide information about concentrations in environmental media at these sites.

Soil sampling and analysis at selected grid points was conducted between 1985 and 1989; however, these grid points do not correspond to particular waste management units. The grid points are located in the corners of the Semi-Works Aggregate Area, and are not likely to be representative of

1 conditions near the 201-C Process Building or Critical Mass Laboratory.
2 Locations of soil sampling points were changed in 1990; however, the one
3 sample taken within the Semi-Works Aggregate Area is not located near a
4 waste management unit. The data can be used as a general indicator of
5 the impacts of historical operations at the Hanford Site, but cannot be
6 ascribed to a particular waste management unit and so do not assist in
7 decision-making on a unit-by-unit basis.

- 8
9 • Biota sampling—limited to non-waste unit-specific samples of vegetation
10 taken in the vicinity of the Semi-Works Complex. These data could assist
11 assessment of bio-uptake and bio-transfer pathways (Issue 5).
12
- 13 • Borehole geophysics gamma logging surveys—performed for some units
14 which discharged to the soil column (cribs and ponds), the surveys were
15 designed to detect the presence of gamma-emitting radionuclides in the
16 subsurface and to indicate whether these materials are migrating vertically
17 (Issue 5). These data are limited by the method's inability to identify
18 specific radionuclides and, thus, to differentiate naturally occurring
19 radioactive materials from possible releases. Variations in quality control
20 further limit the comparability and possible use of these data for estimation
21 of concentrations.
22

23 Besides these historical data, additional borehole geophysical data will be available
24 through the Radionuclide Logging System (RLS), being carried out at the time of this
25 report and in support of the AAMS process. Like the previous (gross gamma) logging
26 conducted at the Semi-Works Aggregate Area, the RLS detects only gamma rays and
27 thus cannot detect some species of radionuclides. However, unlike the gross gamma
28 surveys, the RLS is designed to identify individual radionuclide species through their
29 characteristic gamma ray photon energy levels. It should thus be able to differentiate
30 naturally occurring radionuclides from those resulting from releases. It will also (like
31 gross gamma logging) determine the vertical extent of the presence of the radionuclides.
32

33 Based on the above summary, the available data are considered to be of varying
34 quality. The chemical analysis data have not been validated, a process generally required
35 for risk assessment or final ROD purposes. The radiation survey data are based on field
36 methods, which are generally applicable only for screening purposes, and can be used to
37 focus future activities, such as sampling and analysis plans.
38

39 The available data are considered to be deficient in one or more of the following
40 areas:
41

- The gross gamma logging data are unable to differentiate the various radionuclides that may have been present at the time of the survey.
- Conditions at the unplanned release locations have been altered (especially by remediation and decommissioning activities) since the time of the survey or sampling, and it is likely that contaminant distributions have changed.
- Surveys or sampling was performed at a location different from the waste management unit or unplanned release, and so would not be representative of the concentrations in the zone of release. This deficiency applies to horizontal and vertical differences in location: the borehole geophysics data may be at the correct depths, but the distance of the borehole from the waste management unit or unplanned release can severely attenuate the gamma-radiation that is used to indicate contamination; similarly, surface sampling and surveys cannot establish subsurface contaminant concentrations or even disprove the possible presence of some radioactive constituents (particularly alpha-emitting transuranic elements).
- There has been virtually no measurement of non-radioactive hazardous constituents in environmental media in the Semi-Works Aggregate Area. At present, the presence of these constituents must be conjectured based on waste disposal inventories.

As a result of these deficiencies, the existing data are not considered to be usable for input to a quantitative risk assessment or for comparison to ARARs.

In addition to the above data, there are also data relating to site conditions (Issue 2) which do not directly relate to the presence of environmental release but which will assist in the assessment of its potential migration if present. These data are generally summarized in the Topical Reports prepared for this aggregate area. These will include the following:

- *Geologic Setting of the 200 East Area: An Update* (Lindsey et al. 1992) includes descriptions of regional stratigraphy, structural geology, and local (200 East) stratigraphy, with revised structure and isopach maps of the various unconsolidated strata found beneath the 200 East Area.
- *Geologic and Geophysical Logs from Monitoring Wells in the Semi-Works Aggregate Area* (Chamness et al. 1992) contain data from three wells drilled to groundwater as well as data from 10 shallow (<15.2 m [<50 ft]) vadose wells. These data include drillers or geologist logs and natural gamma logs where available.

1 The data in these topical reports were obtained for the AAMS based on a review
2 of driller, geological, and geophysical logs for the wells drilled in the Semi-Works
3 Aggregate Area as well as information in Lindsey et al. (1992). Existing cross sections,
4 isopach maps, and structure maps were adapted to the specific needs of this report and
5 presented in Section 3. Only existing logs were used; no new wells were drilled as part of
6 this study. The quality of both the geologic and geophysical data varies with the age of
7 the well and the scope of the study that the data were supporting, but is generally
8 sufficient for general geologic characterization of the site. Issues involving the potential
9 for contaminant migration at specific sites may not be fully addressed through any
10 existing boring or wells because appropriate borings may not be located in close
11 proximity; these issues should be addressed during subsequent field investigations at
12 locations where contaminant migration is considered likely.

13
14 Another class of data which was gathered in the general area of the 200 East
15 Area, and thus is potentially appropriate to the Semi-Works Aggregate Area, is the result
16 of a set of studies which were performed for the Basalt Waste Isolation Project (BWIP)
17 (DOE 1988a), in an attempt to site a high-level radioactive waste geologic repository in
18 the basalt beneath and in the vicinity of the Hanford Site. The proposed Reference
19 Repository Site included the 200 West Area and some distance beyond it, mainly to the
20 west. For this siting project, a number of geologic techniques were used, and some of
21 the data generated by the drilling program have been used for the stratigraphic
22 interpretation presented in Section 3.4 and a number of the figures used in this and other
23 sections of Section 3.0. The program also included a number of geophysical studies,
24 using the following techniques:

- 25
- 26 • Gravity
- 27
- 28 • Magnetics
- 29
- 30 • Seismic reflection
- 31
- 32 • Seismic refraction
- 33
- 34 • Magnetotellurics.
- 35

36 These data, as presented in Section 1.3.2.2.3 of DOE (1988a), were reviewed for
37 their relevance to the present Semi-Works AAMS. The limitations of these studies
38 include the following aspects:

- 39
- 40 • Most of the studies covered a regional scale with lines or coverages that
- 41 may have crossed the Semi-Works Aggregate Area (or even the 200 East

Area) only in passing. Some of the surveys (e.g., the grid of gravity stations) specifically avoided the 200 East Area ("due to restricted access").

- Many of the techniques are more sensitive to the basalt than to the suprabasalt sediments of specific interest in the AAMS program and even less sensitive to the features which are closer to the surface, as is applicable to the source area AAMS. Basalt is by nature much denser than the unconsolidated sediments and has more consistent magnetic properties, therefore it also has a characteristic seismic signature. In addition, the analysis of the data emphasized the basalt features which were apparent in the data. All this is appropriate to a study of the basalt, but does not make the results applicable to the present study.
- Even when features potentially caused by shallow sediments are identified, they are interpreted either very generally (e.g., "erosional features in the Hanford formation and (or) Ringold Formations") or as complications (e.g., "shallow sediment velocity variations causing stacking velocity correction errors"). There are only a very few features, none of which are in the Semi-Works Aggregate Area, which are interpreted as descriptive of the structure of the suprabasalt sediments.
- Lastly, some of the anomalies which are interpreted in terms of a sedimentary stratigraphic cause (e.g., "erosion of Middle Ringold") do not bear up under the more detailed stratigraphic interpretation carried out under the Topical Reports for the AAMS (Lindsey et al. 1992 and Chamness et al. 1992).

However, these data will be reviewed in more detail for the purposes of the 200 East Area Groundwater AAMS, since deeper features, including the basalt, are of more concern for that study.

Other data presented in Sections 2.0, 3.0, and 4.0 are broad-scale rather than site-specific, as are the contaminant concentrations. These include topography, meteorology, surface hydrology, environmental resources, human resources, and contaminant characteristics. These data are generally of acceptable quality for the purposes of planning remedial actions in the Semi-Works Aggregate Area.

8.1.3 Evaluation of Available Data

The EPA (1987) has specified indicators of data quality, the five "PARCC" parameters (precision, accuracy, representativeness, comparability, and completeness), which can be used to evaluate the existing data and to specify requirements for future data collection.

- Precision—the reproducibility of the data
- Accuracy—the lack of a bias in the data.

Much of the existing data are of limited precision and accuracy due to the analytical methods which have been used historically. The gross gamma borehole geophysical logging in particular is limited by methodological problems although reproducibility has been generally observed in the data. Conditions that have contributed to lack of precision and/or accuracy include: improvements in analytical instrumentation and methodology making older data incompatible; effects of background levels (particularly regarding radioactivity and inorganics); and lack of quality control on data acquisition.

The limitations in precision and accuracy in existing data are mainly due to the progress of analytical methodologies and QA procedures since the time they were collected. The *Hanford Site Past-Practice Strategy* (DOE/RL 1992) recommends that existing data be used to the maximum extent possible, at two levels: first to formulate the conceptual model, conduct a qualitative risk assessment, and prepare work plans, but also as an initial data set which can be the basis for a fully-qualified data set through a process of review, evaluation, and confirmation.

- Representativeness—the degree to which the appropriate environmental parameters or media have been sampled.

This parameter highlights a shortcoming of most of the historical data. Limitations include the observation only of gross gamma radiation rather than differentiating it by radionuclide (e.g., through spectral surveying methods as are being used by the RLS program), the analysis of samples only for radionuclides rather than for chemicals and radionuclides, and the failure to sample (especially in the subsurface) for the full potential extent of contaminant migration.

1 The data are incomplete primarily because of the lack of subsurface
2 sampling for extent of contamination. The lack of these data is also caused
3 by concerns to limit the potential exposure to radioactivity of workers who
4 would have to drill in contaminated areas and the possible release or
5 spread of contamination through these intrusive procedures. The result of
6 this data gap is that none of the sites can be demonstrated to have
7 contamination either above or below levels of regulatory concern, and a
8 quantitative risk assessment cannot be conducted.
9

10 In addition, in many cases it has been necessary to use general data from
11 elsewhere in the 200 East Area or even from the vicinity of the 200 Areas
12 rather than data specific to a particular waste management unit. For most
13 purposes of characterization for transport mechanisms, this procedure is
14 acceptable given the screening level of the present study. For example,
15 while it is appropriate to use the limited number of boring logs available to
16 characterize the stratigraphy in the Semi-Works Aggregate Area (Chamness
17 et al. 1992 and Lindsey et al. 1992), the later, waste management unit-
18 specific, field sampling plans will require more detailed consideration of the
19 geology beneath that unit.
20

- 21 • Comparability—the confidence that can be placed in the comparison to two
22 data sets (e.g., separate samplings).
23
- 24 • Completeness—the fraction of samples which are considered "valid."
25

26 None of the data that have been previously gathered in the Semi-Works
27 Aggregate Area has been "validated" in the EPA Contract Laboratory
28 Program (CLP) sense, although varying levels of quality control have been
29 applied to the sampling and analysis procedures.
30

31 With varying levels of quality control and varying procedures for sample
32 acquisition and analysis, this parameter is also generally poorly met. QA
33 procedures have become more stringent in recent years, so that much of
34 the older data may not be considered valid based on current data validation
35 guidelines.
36

37 While these limitations cannot in most cases be quantified and some such as
38 representativeness are specifically qualitative, most of the data gathered in the Semi-
39 Works Aggregate Area can be cited as failing one or more of the PARCC parameters.
40 These data should, however, be used to the maximum extent in the development of work
41 plans for site field investigations, prioritization of the various units, and to determine, to
42 the extent possible, where contamination is or is not present.

1 In addition to these site-specific data, there are also a limited number of non-
2 site-specific sampling events that are being developed to determine background levels of
3 naturally occurring constituents (Hoover and LeGore 1991). These data can be used to
4 differentiate the effect of the environmental releases from naturally occurring background
5 levels.

8 8.1.4 Conceptual Model

10 The initial conceptual model of the waste management units in the Semi-Works
11 Aggregate Area is presented and described in Section 4.2 (Figure 4-4). The model is
12 based on best judgement of where contaminants were discharged and their potential for
13 migration from release points. The conceptual model is designed to be conservatively
14 inclusive in the face of a lack of data. This means that a migration pathway was included
15 if there is any possibility of contamination traveling by that route, historically or at
16 present. There may not be a significant flux of such contaminant migration for many of
17 the pathways shown on the figure.

19 The pathways from the tanks, cribs, reverse well, ditch, pond, and burial unit
20 leading to adsorption of transuranic elements on vadose-zone soils are possibly the most
21 significant. These and other pathways can be traced on the conceptual model. All are
22 possible; only a few are likely because of the conservatism inherent in including all
23 conceivable pathways. More importantly, even if a pathway carries significant levels of a
24 contaminant, it still may not have carried contamination to the ultimate receptors, human
25 or ecological. This can only be assessed by sampling at the exposure point on this
26 pathway, or sampling at some other point and extrapolating to the exposure point, to
27 estimate the dose to the receptors.

29 There are significant uncertainties in the contaminant levels transported via the
30 migration pathways shown on the conceptual model, yet almost none of these pathways
31 has been investigated to determine whether any contamination still exists at the source
32 locations shown in the conceptual model, and if so which constituents are present, at
33 what levels, and how they are distributed.

36 8.1.5 Aggregate Area Management Study Objectives and Decisions

38 The specific objectives of the Semi-Works AAMS are listed in Section 1.3. They
39 include (in part) the following:

- 41 • Assemble site data (as described in Section 8.1.2)

- 1 • Develop a site conceptual model (see Section 8.1.4)
- 2
- 3 • Identify contaminants of concern and their distribution (Section 4.0)
- 4
- 5 • Identify preliminary applicable, or relevant and appropriate, regulations
- 6 (ARARs, Section 6.0)
- 7
- 8 • Define preliminary remedial action objectives and screen potential remedial
- 9 technologies to prepare preliminary remedial action alternatives (Section
- 10 7.0)
- 11
- 12 • Recommend expedited, interim, or limited actions (Section 9.0)
- 13
- 14 • Define and prioritize work plan activities with emphasis on supporting early
- 15 cleanup actions and records of decision.
- 16

17 The decisions that will have to be made on the basis of this AAMS can best be
18 described according to the *Hanford Site Past-Practice Strategy* (DOE/RL 1992) decisional
19 flow chart (Figure 1-2 in Section 1.0) that must be followed on a site-by-site basis.
20 Decisions are shown on the flow chart as diamond-shaped boxes, and include the
21 following:

- 22
- 23 • Is an ERA justified?
- 24
- 25 • Is response need in less than six months (is the ERA time critical)?
- 26
- 27 • Are data sufficient to formulate the conceptual model and perform a
- 28 qualitative risk assessment?
- 29
- 30 • Is an IRM justified?
- 31
- 32 • Can the remedy be selected?
- 33
- 34 • Can additional required data be obtained by an LFI?
- 35
- 36 • Are data from field investigations sufficient to perform a risk assessment?
- 37
- 38 • Can an Operable Unit/Aggregate Area ROD be issued?
- 39

40 The last two questions will only be asked after additional data are obtained
41 through field investigations, and therefore are DQO issues only in assessing scoping for
42 those investigations.

1 Most of these decisions are actually a complicated mixture of many smaller
2 questions, and will be addressed in Section 9.0 in a more detailed flowchart for assessing
3 the need for remediation or investigation.

4
5 Similarly, the tasks that will need to be performed after the AAMS that drive the
6 data needs for the study are found in the rectangular boxes on the flow chart. These
7 include the following:

- 8
9 • ERA (if justified)
- 10
11 • Definition of threshold contamination levels, and formulation of conceptual
12 model, performance of qualitative risk assessment and FS screening (IRM
13 preliminaries)
- 14
15 • FFS for IRM selection
- 16
17 • Determination of minimum data requirements for IRM path
- 18
19 • Negotiation of Scope of Work, relative priority, and incorporation into
20 integrated schedule, performance of LFI
- 21
22 • Determination of minimum data needs for risk assessment and final
23 Remedy Selection (preparation of RI/FS pathway).

24
25 These stages of the investigation must be considered in assessing data needs
26 (Section 8.2.2).

27 28 29 **8.2 DATA USES AND NEEDS (STAGE 2 OF THE DQO PROCESS)**

30
31 Stage 2 of the DQO development process (EPA 1987) defines data uses and
32 specifies the types of data needed to meet the project objectives. These data uses and
33 needs are based on the Stage 1 results, but must be more specific. The elements of this
34 stage of the DQO process include:

- 35
36 • Identifying data uses (Section 8.2.1)
- 37
38 • Identifying data types (Section 8.2.2.1)
- 39
40 • Identifying data quality needs (Section 8.2.2.2)
- 41
42 • Identifying data quantity needs (Section 8.2.2.3)

- Evaluating sampling/analysis options (Section 8.2.2.4)
- Reviewing data quality parameters (Section 8.2.2.5)
- Summarizing data gaps (Section 8.2.3).

Stage 2 is developed on the basis of the conceptual model and the project objectives. The following sections discuss these issues in greater detail.

8.2.1 Data Uses

For the purposes of the remediation in the Semi-Works Aggregate Area, most data uses fall into one or more of four general categories:

- Site characterization
- Public health evaluation and human health and ecological risk assessments
- Evaluation of remedial action alternatives
- Worker health and safety.

Site characterization refers to a process that includes determination and evaluation of the physical and chemical properties of any wastes and contaminated media present at a site, and an evaluation of the nature and extent of contamination. This process normally involves the collection of basic geologic, hydrologic, and meteorologic data but more importantly for the Semi-Works Aggregate Area waste management units, data on specific contaminants and sources that can be incorporated into the conceptual model to indicate the relative significance of the various pathways. Site characterization is not an end in itself, as stressed in the *Hanford Site Past-Practice Strategy* (DOE/RL 1992), but rather the data must work toward the ultimate objectives of assessing the need for remediation according to risk assessment methods, either qualitative or quantitative and providing appropriate means of remediation (through an FFS, FS, or CMS). The understanding of the site characterization, based on existing data, is presented in Sections 2.0, 3.0, and 4.0, and summarized in the conceptual model (Section 4.2).

Data required to conduct a public health evaluation, and human health and ecological risk assessments at the sites in the Semi-Works Aggregate Area include the following: input parameters for various performance assessment models; site characteristics; and contaminant data required to evaluate the threat to public and environmental health and welfare through exposure to the various media. These needs

usually overlap with site characterization needs. An extensive discussion of risk assessment data uses and needs is presented in the Risk Assessment Guidance for Superfund (EPA 1989a). The main deficiency in the data available for waste management units in the Semi-Works Aggregate Area is that it will not support a quantitative assessment of contaminant concentrations for the purposes of risk assessment. The present understanding of site risks is presented in the selection of constituents of concern (Section 4.0). Quantitative risk assessments will be conducted at the Hanford Site with a methodology under development, and the data needs for this methodology will be considered in developing site-specific sampling and analysis plans.

Data are collected to support evaluation of remedial action alternatives for ERAs, IRMs, FFSs, or the full RI/FS, and to perform screening of remedial alternatives, feasibility level design, and preliminary cost estimates. Once an alternative is selected for implementation, much of the data collected during site investigations (LFI or RI) can also be used for the final engineering design. Generally, collection of information during the investigations specifically for use in the final design is not cost-effective because many issues must be decided about appropriate technologies before effective data gathering can be undertaken. It is preferable to gather such specific information during a separate predesign investigation or at the time of remediation using the "observational approach" of the *Hanford Site Past-Practice Strategy*. Based on the existing data, broad remedial action technologies and objectives have been identified in Section 7.0.

The worker health and safety category includes data collected to establish the required level of protection for workers during various investigation activities. These data are used to determine if there is concern for the personnel working in the vicinity of the aggregate area. The results of these assessments are also used in the development of the various safety documents required for field work (see Health and Safety Plan, Appendix B).

It should be noted that each of these data use categories—site characterization, risk assessment needs, remedial actions, and health and safety—will be required at each decision point on the *Hanford Site Past-Practice Strategy* flowchart, as discussed at the end of Section 8.1.5. To the extent possible, however, not all sites will be investigated to the same degree. Sites with the highest priority will receive the most extensive investigation. These results will then be extended to the other, analogous sites which have similar geology and disposal histories (see Section 9.2.3).

The existing data can presently be used for two main purposes:

- Development of site-specific sampling plans (site characterization use)
- Screening for health and safety (worker health and safety use)

1 Table 8-1 presents a summary of the availability of existing data for these two
2 uses. For the purposes of developing sampling plans, existing information is available
3 for:

- 4
5 • The location of sites—many of the waste management units have surface
6 expressions, markers, or have been surveyed in the past. The unplanned
7 releases generally lack this information, as do the 216-C-3 and 216-C-6
8 Cribs and the 241-CX-71 Storage Tank (the actual dimensions of the tank
9 are unknown).
- 10
11 • Possible contamination found at the waste management units—these data
12 are derivable from the inventories for the waste management units (mainly
13 for the specific cribs). However, in the case of waste management units
14 that have an engineered barrier to environmental releases (e.g., the storage
15 tanks), waste inventories do not provide information on whether the
16 surrounding media are contaminated.
- 17
18 • The likely depth of contaminants—this information is mainly obtained from
19 the gross gamma borehole logging for many of the units. We do not have
20 many boreholes nor are these well placed to monitor specific waste
21 management units.

22
23 Two types of information are available for the purposes of worker health and
24 safety and will be used for the development of health and safety documents:

- 25
26 • Levels of surface radiation—derived from the ongoing periodic radiological
27 surveys done under the Environmental Surveillance program (Schmidt et al.
28 1992). Table 8-1 indicates those units where recent surveys have been
29 performed and so an additional survey may not be required before surface
30 activities can be conducted.
- 31
32 • Expected maximum contaminant levels—these data are based mainly on
33 the results of subsurface soil sampling. Sampling of this type has not been
34 conducted for Semi-Works Aggregate Area waste management units or
35 unplanned releases. Maximum levels of radionuclides in surface soils can
36 be roughly estimated from the surface radiation surveys; however, these
37 data cannot be used to identify specific radionuclides.

38
39 Table 8-1 also presents a first expression of the data needs for the individual
40 waste management units and unplanned releases in the Semi-Works Aggregate Area,
41 which must be addressed for remediation approaches to be developed.
42

8.2.2 Data Needs

The data needs for the Semi-Works Aggregate Area are discussed in the following sections according to the categories of types of data (Section 8.2.2.1), quality (8.2.2.2), quantity (8.2.2.3), options for acquiring the data (8.2.2.4), and appropriate DQO (PARCC) parameters (8.2.2.5). These considerations are summarized for each waste management unit category in the Semi-Works Aggregate Area (Section 8.2.3).

8.2.2.1 Data Types. Data use categories described in Section 8.2.1 define the general purpose of collecting additional data. Based on the intended uses, a concise statement regarding the data types needed can be developed. Data types specified at this stage should not be limited to chemical parameters, but should also include necessary physical parameters such as bulk density and moisture. Since environmental media and source materials are interrelated, data types used to evaluate one media may also be useful to characterize another media. The data type requirements for the remedial action alternatives identified in Section 7.4 are summarized in Table 8-2.

Identifying data types by media indicates that there are overlapping data needs. Data objectives proposed for collection in the site investigations at waste management units and unplanned releases in the Semi-Works Aggregate Area are discussed in Section 8.3 to provide focus to methods to aid in investigations.

8.2.2.2 Data Quality Needs. The various tasks and phases of a CERCLA investigation may require different levels of data quality, depending on the purposes of the data, the types of data needed, and the particular CERCLA action being undertaken. Important factors in defining data quality include selecting appropriate analytical levels and validation and identifying contaminant levels of concern as described below. The Westinghouse Hanford document, *A Proposed Data Quality Strategy for Hanford Site Characterization*, will be used to help define these levels (McCain and Johnson 1990).

Chemical and radionuclide laboratory analyses will be one of the most important data types, and are required at virtually all the sites in the Semi-Works Aggregate Area. In general, increasing accuracy, precision, and lower detection limits are obtained with increasing cost and time. Therefore, the analytical level used to obtain data should be commensurate with the intended use. Table 8-3 defines five analytical levels associated with different types of characterization efforts. While the bulk of the analysis during LFIs/RIs will be screening level (DQO Level I or II), these data will require confirmation sampling and analysis to allow final remedial decisions through quantitative risk assessment methods. Individual DQO analytical PARCC parameters for Level III or IV analytical data associated with contaminants of potential concern in the Semi-Works Aggregate Area (as developed in Section 4.0) are given in Table 8-4. These parameters

1 will be used for the development of site-specific sampling and analysis plans and quality
2 assurance plans for investigations and remediation in the aggregate area.

3
4 Before laboratory or even field data can be used in the selection of the final
5 remedial action, they must first be validated. Exceptions are made for initial evaluations
6 of the sites using existing data, which may not be appropriate for validation but will be
7 used on a screening basis based on the *Hanford Site Past-Practice Strategy*. Exceptions for
8 other screening data, including estimates of contaminant concentration inferred from field
9 analyses, may also be made. Validation involves determining the suitability and quality of
10 the data. Once data are validated, they can be used to successfully complete the
11 remedial action selection process. Activities involved in the data validation process
12 include the following:

- 13
- 14 • Verification of chain of custody and sample holding times
- 15
- 16 • Confirmation that laboratory data meet QA/QC criteria
- 17
- 18 • Confirmation of the suitability and quality of field data, which includes
- 19 geological logs, hydrologic data, and geophysical surveys
- 20
- 21 • Proper documentation and management of data so that they are usable.
- 22

23 Validation may be performed by qualified Westinghouse Hanford personnel from
24 the Office of Sample Management (OSM), other Westinghouse Hanford organizations,
25 or a qualified independent participant subcontractor. Data validation of laboratory
26 analyses will be performed in accordance with *A Proposed Data Quality Strategy for*
27 *Hanford Site Characterization* (McCain and Johnson 1990) and standards set forth by
28 Westinghouse Hanford.

29
30 To accomplish the second task, all laboratory data must meet the requirements of
31 the specific QA/QC parameters as set up in the Quality Assurance Project Plan (QAPP)
32 for the project before it can be considered usable. The QA/QC parameters address
33 laboratory precision and accuracy, method blanks, instrument calibration, and holding
34 times.

35
36 The suitability of field data must be assessed by a trained and qualified person.
37 The project geohydrologist/geophysicists will review the geologic logs, hydrologic data,
38 geophysical surveys, and results of physical testing, on a daily basis, and senior technical
39 reviews will be conducted periodically throughout the project.

40
41 Data management procedures are also necessary for the validation. Data
42 management includes proper documentation of field activities, sample management and

tracking, and document and inventory control. Specific consistent procedures are discussed in the Information Management Overview (Appendix D).

8.2.2.3 Data Quantity Needs. The number of samples that need to be collected during an investigation can be determined by using several approaches. In instances where data are lacking or are limited, such as for contamination in the vadose zone soils, a phased sampling approach will be appropriate. In the absence of any available data, an approach or rationale will need to be developed to justify the sampling locations and the numbers of samples selected. Specific locations and numbers of samples will be determined based on data collected during screening activities. For example, the number and location of beta/gamma spectrometer probe locations can be based on results of surface geophysical and radiation surveys. These may help locate some subsurface features which may not be adequately documented. Details of any higher DQO level subsurface soil sampling scheme will depend on results of screening investigations such as geophysics surveys, surface radiation surveys, and beta/gamma spectrometer probe surveys. In situations where available data are more complete, statistical techniques may be useful in determining the additional data required.

8.2.2.4 Sampling and Analysis Options. Data collection activities are structured to obtain the needed data in a cost-effective manner. A sampling and analysis approach that ensures that appropriate data quality and quantity are obtained with the resources available may be developed by using field screening techniques and focusing the higher DQO level analyses on a limited set of samples at each site. The investigations of waste management units and unplanned release sites in the Semi-Works Aggregate Area should take advantage of this approach for a comprehensive characterization of the site in a cost-effective manner.

A combination of lower level (Levels I, II, and III) and higher level analytical data (Levels IV and V) should be collected. For instance, at least one of the samples collected from each source (including contaminated surface soil at unplanned release locations) should be analyzed at DQO Level IV or V and validated to provide high quality data to confirm the less expensive but more extensive lower level analyses. This approach would provide the certainty necessary to determine contaminants present near the sources. Samples collected from the other media, such as subsurface soils and sediments, will be analyzed by Test Methods for Evaluating Solid Wastes, (EPA 1986), CLP (EPA 1988a and 1988b), Methods for Chemical Analysis of Water and Wastes (EPA 1983), or Prescribed Procedures for Measurement of Radioactivity in Drinking Water (EPA 1980).

8.2.2.5 Data Quality Parameters. The PARCC parameters are indicators of data quality. Ideally, the end use of the data collected should define the necessary PARCC parameters. Once the PARCC requirements have been identified, then appropriate

1 analytical methods can be chosen to meet established goals and requirements.

2 Definitions of the PARCC parameters are presented in Section 8.1.2.

3
4 In general the precision and accuracy objectives are governed by the capabilities
5 of the available methodologies and in most cases these are more than adequate for the
6 needs of the investigations. Chemical analyses can usually attain parts per billion
7 detection range in soils and water, and this level is generally adequate to the needs of the
8 risk assessment. Radiological analyses reach similar levels. Some constituents, such as
9 arsenic, require analysis to much lower levels to evaluate risk, but this may be impossible
10 because of the limitations of analytical methods and the effects of natural background
11 levels. In addition, risk assessment is conventionally computed only to a single digit of
12 precision and uses conservative assumptions, which reduces the impact of measurement
13 accuracy on the accuracy of the risk determination.

14
15 For other measurements, such as physical parameters, the precision and accuracy
16 capabilities of existing measurement technologies are sufficient for the evaluation
17 methods used to produce characterization data, so the objectives are based on the
18 limitations of the analysis methodologies.

19
20 Representativeness is maintained by fitting the sampling program to the governing
21 aspects of the sources and transport processes of the site, as demonstrated in the site
22 conceptual model (Section 4.2). Initial sampling should concentrate on sources, which
23 are fairly well-understood, and on representative locations of anticipated contaminant
24 transport. If necessary, following activities can focus on aspects or locations that were
25 not anticipated but were demonstrated by the more general results.

26
27 Completeness is generally attained by specifying redundancy on critical samples
28 and maintaining quality control on their acquisition and analysis. As with
29 representativeness, the initial sampling program may lead to modifications of which
30 samples should be considered critical during subsequent sampling activities.

31
32 Comparability will be met through the use of Westinghouse Hanford standard
33 procedures generally incorporated into the *Environmental Investigation and Site*
34 *Characterization Manual* (WHC 1988c).

35 36 37 **8.2.3 Data Gaps**

38
39 Considering the data needs developed in Section 8.2.2, and the data available to
40 meet these needs as presented in Section 8.1.2, it is apparent that a number of data gaps
41 can be identified. These are summarized, on a waste management unit and unplanned
42 release category basis in Table 8-5, and should be the focus of LFIs on a category basis,

1 using the analogous sites approach. Acquisition of contaminant concentration data is the
2 highest priority because of the need to assess remediation and appropriate remedial
3 actions for each category.
4

5 In addition to these data needs specifically addressing contamination problems at
6 sites included for consideration in this aggregate area, there are general data needs which
7 will be required for characterization of the possible transport pathways, as presented in
8 the conceptual model, at locations away from the individual waste management units and
9 unplanned release sites. These general, non-site-specific needs include characterization
10 of the following:
11

- 12 • Geologic stratigraphy, particularly for possible perched water zones
- 13
- 14 • Air transport of contamination
- 15
- 16 • Ecological impacts and transport mechanisms, including bio-uptake,
17 bio-concentration, and secondary receptors through predation
- 18
- 19 • Potential releases from process effluent lines between facilities and to waste
20 disposal sites.
21

22 All of these needs will have to be addressed in the data collection program
23 (Section 8.3).
24
25

26 **8.3 DATA COLLECTION PROGRAM (STAGE 3 OF THE DQO PROCESS)**

27

28 The data collection program is Stage 3 of the process to develop DQOs.
29 Conducting an investigation with a mixture of screening and higher level data is a
30 common method for optimizing the quantity and quality of the data collected. It would
31 be very inefficient and overly expensive to specify beforehand all the types of samples
32 and analyses that will yield the most complete and accurate understanding of the
33 contamination and physical behavior of the site. Data adequate to achieve all the goals
34 and objectives for remedial action decisions are obtained at a lower cost by using the
35 information obtained in the field to focus the ongoing investigation and remediation
36 process.
37

38 Initial sampling should collect new data believed most necessary to confirm and
39 refine the conceptual model particularly at priority sites. Sampling may then be extended
40 to further reduce uncertainty, to fill in remaining data gaps, to collect more detailed
41 information for certain points where such information is required, or to conduct any
42 needed treatability studies or otherwise support the data needs of the remedial action

1 selection process. An alternative of extrapolating the data from a limited number of
2 waste management units to other analogous ones will also be used. The need for
3 subsequent investigation phases will be assessed throughout the investigation and
4 remediation activities as data become available. Assessing completeness of the
5 investigation data through a formal statistical procedure is not possible, given the
6 complexity and uncertainty of the parameters required to describe the site and the time
7 to make decisions. Rather, the use of engineering judgment is considered sufficient to
8 the decision process.

11 8.3.1 General Rationale

13 The general rationale for the investigation of waste management units in the
14 Semi-Works Aggregate Area is to collect needed data that are not available. Because of
15 the size of the aggregate area, the complexity of past operations, and the number of
16 unplanned releases and waste management units, a large amount of new information will
17 be required such as the specific radionuclides and chemicals present, their spatial
18 distribution and form, and the presence of special migration pathways, such as perched
19 groundwater systems.

21 The following work plan approach will be used for LFI and RI/FS in the Semi-
22 Works Aggregate Area. The methodology is described in Sections 8.3.2 and 8.3.3 in a
23 general form.

- 25 • Existing data as described in Sections 2.0, 3.0, and 4.0 should be used to
26 the maximum extent possible. Although existing data are not validated
27 fully, the data are still useful in developing a preliminary conceptual model
28 (Section 4.2) and in helping to focus and guide the planning of
29 investigations, expedited actions, and interim measures.
- 31 • Additional data at validated and screening levels should be collected to
32 obtain the maximum amount of useful information for the amount of time
33 and resources invested in the investigation.
- 35 • Data should be collected to support the intended data uses identified in
36 Section 8.2.1.
- 38 • Non-intrusive sampling, such as geophysical surveys, surface radiation
39 surveys, soil gas, and spectral gamma probe surveys, and surficial and
40 source sampling should be conducted early in any investigation effort to
41 identify necessary interim response actions (i.e., additional ERAs or IRMs).

- Data collected from initial investigation activities should be used to confirm and refine the conceptual model (Section 4.2), refine the analyte constituents of concern, and provide information to conduct interim response actions or risk assessment activities.
- Additional investigation activities are proposed to support (if needed) quantitative baseline risk assessments for final cleanup actions and further refine the conceptual model.
- Field investigation techniques should be used to minimize the amount of hazardous or mixed waste generated. Any waste generated will be handled in accordance with EII 4.2, *Interim Control of Unknown Suspected Hazardous and Mixed Waste* (WHC 1988d).

8.3.2 General Strategy

The overall objective of any field investigation (LFI, IRM, or RI) of the sites in the Semi-Works Aggregate Area will be to gather additional information to support risk assessment and remedial action selection according to the *Hanford Site Past-Practice Strategy* (DOE/RL 1992) flow chart discussed in Section 8.1.5. The general approach or strategy for obtaining this additional information is presented below.

- Analytical parameter selection should be based on verifying the contaminants present and then narrowed to specific constituents of concern, taking into consideration regulatory requirements and site conditions. Periodic analyses of the long list of parameters should be conducted to verify that the list of constituents of concern has not changed, either because new constituents are identified or some of those considered as a potential concern do not appear to be significant.
- Similarly, investigations should work from a screening level (DQO Levels I or II, e.g., surface radiation surveys) to successively more specific sampling and analysis methodologies (e.g., beta/gamma spectral probes, then DQO Level III or IV soil sampling and analysis), without time consuming remobilizations.
- Dangerous and radioactive wastes may be generated during the field investigation. While efforts should be made to minimize these wastes, any waste generated will be handled in accordance with EII 4.2, "Interim Control of Unknown Suspected Hazardous and Mixed Waste" (WHC

1988d). The analyses of samples for constituents of concern will allow wastes generated to be adequately designated.

8.3.3 Investigation Methodology

Initial field investigations (mainly LFIs, but also associated with IRMs at appropriate sites and possibly some RIs) may include some or all of the following integrated methodologies:

- Source Investigation (Section 8.3.3.1)
- Geological Investigation (Section 8.3.3.2)
- Surface Water Sediment Investigation (Section 8.3.3.3)
- Soil Investigation (Section 8.3.3.4)
- Air Investigation (Section 8.3.3.5)
- Ecological Investigation (Section 8.3.3.6)
- Geophysical Stratigraphic Survey (Section 8.3.3.7)
- Process Effluent Pipeline Integrity Assessment (Section 8.3.3.8)
- Geodetic Survey (Section 8.3.3.9).

Each investigation methodology is briefly outlined in the following sections. Specific survey methods (such as electromagnetics or ground-penetrating radar) have not been recommended in order to allow flexibility in the development of field sampling plans which can be sensitive to very local conditions. A summary of the applicable methods for each waste management unit and unplanned release is presented in Table 8-6. Table 8-6 also identifies groups of analogous sites as well as units considered to be representative analogues for limited field investigations. In addition, some of the data needs, such as stratigraphy interpretation, must be addressed on an area-wide basis. More detailed descriptions and specific methods and instrumentation will be included in site-specific work plans, sampling and analysis plans, and field sampling plans for LFIs/IRMs at waste management units and unplanned releases that require these investigations.

1 These investigations are discussed below in the approximate order of priority.
2 The source investigation is the highest priority because of its importance to the decisions
3 about remedial action on a site-by-site basis. The other investigations are of lower
4 priority and should be conducted according to the need to determine whether
5 contamination has been transported beyond the immediate vicinity of the waste
6 management units. To some extent this need will depend on the results of the source
7 investigation.

8
9 **8.3.3.1 Source Investigation.** The purpose of source investigation activities in the Semi-
10 Works Aggregate Area is to characterize the known waste management units and
11 unplanned releases that exist in the area and that may contribute to contamination of
12 surface soil, vadose zone, surface water, sediment, air, and biota. The completeness of
13 the characterization effort will be assessed according to the needs of risk assessment and
14 remedial action selection, which will also determine what levels of the various
15 constituents of concern comprise "contamination."

16
17 Source sampling should be conducted at waste management units or unplanned
18 release locations where the available data indicate that dangerous, mixed, or radioactive
19 wastes may be present. Activities which are proposed to be performed during the source
20 investigations include the following:

- 21
22 • Compile and evaluate additional existing data for the purpose of: verifying
23 locations, specifications of engineered facilities and pipelines, and waste
24 stream characteristics; assessment of the construction and condition of
25 boreholes/wells that exist in the operable unit and their suitability for use
26 for investigation activities, QA/QC information, and raw data regarding
27 radiological and hazardous substances monitoring; and integrating any
28 additional environmental modeling data into the conceptual model. This
29 has been done (on an aggregate area basis) in this report; the process will
30 be extended to site-specific planning and on-going assessments of the
31 investigation/remediation as it is carried out.
- 32
33 • Conduct surface radiological surveys of suspected or known source areas to
34 verify locations and nature of surface and subsurface radiological
35 contamination. Conditions at specific sources within a waste management
36 unit should also be noted in order to plan sampling/remediation activities
37 and worker health and safety.
- 38
39 • Conduct non-intrusive surface geophysical surveys at specific waste
40 management units such as the 216-C-3 and 216-C-6 Cribs, 241-CX-71
41 Storage Tank, and 216-C-9 Pond/218-C-9 Burial Ground to verify the exact
42 locations and physical characteristics of these units. Data generated from

these activities can be used in planning intrusive source sampling activities and in locating buried structures identified with waste management units.

- Conduct beta/gamma spectrometer probe surveys to screen for near-surface contamination and to confirm the absence or presence of specific radionuclides of particular concern. Existing boreholes will be used to the maximum extent, but new boreholes may be needed at many locations (to be decided based on screening results). Logging will be done both by NaI detectors or μ R meters for rapid screening as well as the RLS high purity germanium logging system. Westinghouse Hanford will develop an EII Procedure for the beta/gamma spectrometer probe survey. This beta/gamma spectrometer survey serves two purposes depending on the source conditions: to confirm absence of contamination in the near-surface soils, and to serve as a screening tool to choose locations and quantities of vadose zone soil borings. The RLS procedure could demonstrate "assay quality" data for radionuclide concentrations, but will probably continue to require supporting Level IV soil analysis data to allow a risk assessment before final remedial decisions. The need to conduct this survey will be based (at least in part) on the screening results of the surface survey and on information about site burial.
- Soil gas surveys should be conducted at waste management units (such as cribs) where volatile organic chemicals are suspected, as a screening method to identify compounds such as solvents and degreasers that may have been used in separate processes or decontamination activities. The soil gas surveys will be useful in evaluating the extent of contamination near the 216-C-1 and 216-C-4 Cribs. The soil gas survey should not be considered conclusive proof that volatile organic compounds at lower concentrations are not present. Data from the soil gas survey can be used to help locate surface and near-surface samples and vadose zone borings.
- Collect surface and near-surface samples of contaminated soils and/or waste materials at selected locations. Specific sampling sites will be chosen to assess particular facilities or releases. Additional sampling sites may be specified based on results from non-intrusive investigations.
- Wipe samples should be collected as part of the investigations of surface contamination of building (piping or pavement) surfaces. The wipe sample locations can be selected based on visual observations and a surface radiation survey conducted during a site walkthrough. The methodology may be limited by the presence of soil, rough concrete, or paving and so

may not be heavily used except as confirmation following removal of loose contamination.

8.3.3.2 Geologic Investigation. A geologic investigation should be performed to better characterize the vadose zone and the nature of unsaturated soils that make up this system. The geologic investigation will include the following tasks:

- Borings may be advanced into zones where an accurate interpolation of the subsurface stratigraphy is important to understanding migration pathways in the vadose zone.
- Geologic data collected during the ongoing vadose zone soil (Section 8.3.3.4) and other (deeper) investigations (e.g., geologic and geophysical logs from groundwater well installations for groundwater AAMSs) will be compared, compiled, and evaluated.

8.3.3.3 Surface Water/Sediment Investigation. A surface water sediment investigation should be conducted. The investigation will include:

- Radiation survey along the 200 East Powerhouse Ditch for health and safety purposes and to determine whether areas of elevated radiation exist for selection of specific sediment sampling locations.
- Sampling of sediment in the ditch to determine whether inorganics, metals, and organics in the discharge wastewater have concentrated in the sediment.

8.3.3.4 Soil Investigation. The purpose of soil investigations is to determine physical and chemical properties of the soil and to determine the nature, type, and extent of soil contamination associated with waste management units and unplanned releases to allow initiation of interim remedial actions and to assess the quantitative risk at other sites. Sampling will include:

- Samples of vadose zone soil will be collected and analyzed for constituents of concern when wells are drilled for other studies (i.e., groundwater investigations) in the vicinity of a waste management unit or unplanned release with reported liquid disposals or spills. Organic vapor (at sites with suspected volatiles) and radiation sampling should also be performed with samples selected by on-site screening.
- Data collected during this investigation will be evaluated to further understand the contribution of contaminants to the vadose zone from

specific waste management units and/or unplanned releases and to better define the hydrology and water quality in the vadose zone system through moisture content profiles and tracking of specific contaminants.

8.3.3.5 Air Investigation. Air investigations (on an aggregate area scale) should consist of on-site particle sampling as part of the health and safety program. In addition, high-volume air samplers should be placed in appropriate locations based on evaluation of existing meteorological data. The purpose of these samplers will be to determine if any migration of airborne contaminants occurs.

8.3.3.6 Ecological Investigation. Ecological investigation activities, on an aggregate area scale, should include a literature search and data review, and a site walkthrough. These activities are intended to identify potential biota concerns which need to be addressed in the site investigation. Particular emphasis should be given to identifying potential exposure pathways to biota that migrate off site or that introduce contaminants into the food web.

8.3.3.7 Geophysical Stratigraphic Survey. A geophysical survey of subsurface stratigraphy should be conducted across the aggregate area to help characterize the geology and hydrogeology of the vadose zone.

8.3.3.8 Process Effluent Pipeline Integrity Assessment. An assessment of process effluent pipeline integrity should be conducted early in site investigation activities to look for potential leaks and therefore possible areas of contamination. One area of specific concern would be potential leakage from vitreous clay pipes. Initially, as part of this effort, drawings of the process lines and encasements within the aggregate area (Section 2.3.7) should be reviewed and their construction, installation, and operation evaluated. Specific lines will then be selected for integrity assessment with emphasis on lines serving the waste management units that have received large volumes of liquid (e.g., cribs). The priority for investigating pipelines will be segmentally constructed soil column disposal pipelines and unprotected process pipelines. Encased pipelines are regularly sampled for leaks and will receive a lower investigation priority. Investigation of operating high level waste transfer lines will be deferred to their respective programs. Results of the integrity assessments will be evaluated and additional sampling activities may be recommended for subsequent studies. It should be noted that many of the process and liquid waste transfer lines have already been identified and capped as part of the ongoing Semi-Works decommissioning program.

8.3.3.9 Geodetic Survey. Geodetic surveys will be conducted after the installation and completion of each investigation activity. The survey will map the horizontal locations of surface and near-surface soil samples; corners of geophysics, soil gas, and beta/gamma probe surveys; and surface water and sediment sample locations. Horizontal and vertical

1 locations of all vadose zone soil borings and perched zone wells will be surveyed. The
2 geodetic survey should be conducted by a professional surveyor licensed in the State of
3 Washington and should be referenced to both historical (e.g., Hanford coordinates) and
4 current coordinate data (e.g., North American Datum of 1983 - NAD-83), both vertical
5 and horizontal.

8.3.4 Data Evaluation and Decision Making

10 Data will be evaluated as soon as results (e.g., soil gas, radiation screening,
11 drilling) become available for use in restructuring and focusing the investigation activities.
12 Data reports will be developed that summarize and interpret new data. This includes
13 groundwater sampling and RLS borehole logging. Data will be used to refine the
14 conceptual model, further assess potential contaminant-specific ARARs, develop the
15 quantitative risk assessment, and assess remedial action alternatives.

17 The objectives of data evaluation are:

- 19 • To reduce and integrate data to ensure that data gaps are identified and
20 that the goals and objectives of the Semi-Works AAMS are met
- 22 • To confirm that data are representative of the media sampled and that
23 QA/QC criteria have been met.

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9 3 1 2 8 9 3 7 9

Table 8-1. Uses of Existing Data for Semi-Works Aggregate Area Waste Management Units. (Sheet 1 of 3)

Waste Management Unit	Development of Sampling Plans			Health and Safety	
	Location	Possible Contamination	Depth of Contamination	Surface Radiation	Expected Max. Level
Plants, Buildings, and Storage Areas					
201-C Process Building	•	•			
291-C Ventilation System	•	•			
Tanks and Vaults					
241-CX-70 Storage Tank	•	•		•	
241-CX-71 Storage Tank	•				
241-CX-72 Storage Tank	•	•		•	
Cribs and Drains					
216-C-1 Crib	•	•	•	•	
216-C-3 Crib	a	•		•	
216-C-4 Crib	•	•		•	
216-C-5 Crib	•	•	•	•	
216-C-6 Crib	a	•		•	
216-C-7 Crib	•	•		•	
216-C-10 Crib	•	•	•	•	
Reverse Wells					
216-C-2 Reverse Well	•			•	

8T-1a

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Draft A

Table 8-1. Uses of Existing Data for Semi-Works Aggregate Area Waste Management Units. (Sheet 2 of 3)

Waste Management Unit	Development of Sampling Plans			Health and Safety	
	Location	Possible Contamination	Depth of Contamination	Surface Radiation	Expected Max. Level
Ponds, Ditches, and Trenches					
216-C-9 Pond	•	•	•		
200 East Powerhouse Ditch	•	•			
Septic Tanks and Associated Drain Fields					
2607-E-5 Septic Tank and Drain Field	•				
2607-E-7A Septic Tank and Drain Field	•				
Transfer Facilities, Diversion Boxes, and Pipelines					
Semi-Works Valve Pit	•				
Critical Mass Laboratory Valve Pit	•				
241-C-154 Diversion Box	•				
Burial Sites					
218-C-9 Burial Ground	•	•	•		

8T-1b

DOE/RL-92-18
Draft A

Table 8-1. Uses of Existing Data for Semi-Works Aggregate Area Waste Management Units. (Sheet 3 of 3)

Waste Management Unit	Development of Sampling Plans			Health and Safety	
	Location	Possible Contamination	Depth of Contamination	Surface Radiation	Expected Max. Level
Unplanned Releases					
UN-200-E-36	a			•	
UN-200-E-37	a			•	
UN-200-E-98	•	•			
UN-200-E-141	•	•			

Notes:

a Location of these units are known; however, exact boundaries of structure/site are not known.

**Table 8-2. Data Needs for Preliminary Remedial Action Alternatives
Semi-Works Aggregate Area.**

Alternative	Physical Attribute	Chemical/Radiochemical Attribute
1. Multimedia Cover (plus possible vertical barriers)	<ul style="list-style-type: none"> • areal extent • depth of contamination • structural integrity (collapse potential) • runoff/run-on potential • cover properties (permeability) 	<ul style="list-style-type: none"> • surface radiation • biologic transport potential
2. In Situ Grouting/Stabilization	<ul style="list-style-type: none"> • areal extent • depth • particle size • hydraulic properties (permeability/porosity) • stratigraphy • borehole spacing • grout/additive mix parameters 	<ul style="list-style-type: none"> • solubility • reactivity • leachability from grout medium
3. Excavation, Soil Treatment, and Disposal	<ul style="list-style-type: none"> • areal extent^u • depth^u • particle size • silt-size (dust) content • excavation stability 	<ul style="list-style-type: none"> • toxicity/radioactivity • levels of contaminants • solubility/reactivity • soil chemistry (relative affinity) • concentrations in PM-10 fraction • spent solvent treatment/disposal options
4. In Situ vitrification	<ul style="list-style-type: none"> • areal extent • depth • soil/waste conductivity • thermal properties • moisture contact • voids 	<ul style="list-style-type: none"> • volatility • reactivity • leachability/integrity • off-gas treatment waste disposal options
5. Excavation, Above Ground Treatment, and Geologic Disposal	<ul style="list-style-type: none"> • areal extent^u • depth^u • mineralogy of soil/waste • particle size • silt-size (dust) content • excavation stability • treatment parameters 	<ul style="list-style-type: none"> • concentrations of transuranic • toxicity/radioactivity • levels of contaminants • concentrations in PM-10 fraction • reactivity • leachability/integrity of final waste form
6. In Situ Soil Vapor Extraction	<ul style="list-style-type: none"> • areal extent • depth • locations/depth of highest concentrations (vapors, adsorbed) • stratigraphy • soil permeability/porosity • voids 	<ul style="list-style-type: none"> • volatility of constituents (Henry's Law Constant) • non-volatile organics • levels • volatile radionuclides (Radon) • treatability (catalytic oxidization)

^u May be obtained during remediation using the observational approach recommended by the *Hanford Site Past-Practice Strategy* (DOE/RL 1992)

Table 8-3. Analytical Levels for the Semi-Works Aggregate Area.

Level	Description
<u>LEVEL I</u>	Field screening. This level is characterized by the use of portable instruments which can provide real-time data to assist in the optimization of sampling point locations and for health and safety support. Data can be generated regarding the presence or absence of certain contaminants (especially volatiles) at sampling locations.
<u>LEVEL II</u>	Field analysis. This level is characterized by the use of portable analytical instruments which can be used on site, or in mobile laboratories stationed near a site (close-support laboratories). Depending on the types of contaminants, sample matrix, and personnel skill, qualitative and quantitative data can be obtained.
<u>LEVEL III</u>	Laboratory analysis using methods other than the Contract Laboratory Program (CLP) Routine Analytical Services (RAS). This level is used primarily in support of engineering studies using standard EPA-approved procedures. Some procedures may be equivalent to CLP RAS without the CLP requirements for documentation.
<u>LEVEL IV</u>	Contract Laboratory Program (CLP) Routine Analytical Services (RAS). This level is characterized by rigorous QA/QC protocols and documentation and provides qualitative and quantitative analytical data. Some regions have obtained similar support via their own regional laboratories, university laboratories, or other commercial laboratories.
<u>LEVEL V</u>	Nonstandard methods. Analyses which may require method modification and/or development are considered Level V by CLP Special Analytical Services (SAS).

Table 8-4. Data Quality Objective Parameters for Chemical/Radiochemical Analyses. (Sheet 1 of 5)

Radionuclides	Soil/Sediment				Water			
	Analysis ^{1/}	PQL ^{1/} in pCi/g	Precision ^{2/} in RPD	Accuracy ^{2/} in %	Analysis ^{1/}	PQL ^{1/} in pCi/L	Precision ^{2/} in RPD	Accuracy ^{2/} in %
Gross Alpha	900.0 M	TBD	±30	±25	900.0	10	±25	±25
Gross Beta	900.0 M	TBD	±30	±25	900.0	5	±25	±25
Gross Gamma	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Actinium-225	907.0 M	TBD	±30	±25	907.0	TBD	±25	±25
Actinium-227	TBD	TBD	±30	±25	TBD	TBD	±25	±20
Americium-241	Am-01	TBD	±30	±25	Am-03	TBD	±25	±25
Barium-137m	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Bismuth-210	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Bismuth-211	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Bismuth-213	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Bismuth-214	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Cesium-134	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Cesium-137	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Cobalt-60	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Europium-152	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Europium-154	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Europium-155	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Francium-221	TBD	TBD	±30	±25	TBD	TBD	±25	±25

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Table 8-4. Data Quality Objective Parameters for Chemical/Radiochemical Analyses. (Sheet 2 of 5)

Radionuclides	Soil/Sediment				Water			
	Analysis ^{1/}	PQL ^{1/} in pCi/g	Precision ^{2/} in RPD	Accuracy ^{2/} in %	Analysis ^{1/}	PQL ^{1/} in pCi/L	Precision ^{2/} in RPD	Accuracy ^{2/} in %
Lead-209	TBD	TBD	± 30	± 25	TBD	TBD	± 25	± 25
Lead-210	Pb-01 M	TBD	± 30	± 25	Pb-01	TBD	± 25	± 25
Lead-211	TBD	TBD	± 30	± 25	TBD	TBD	± 25	± 25
Lead-214	TBD	TBD	± 30	± 25	TBD	TBD	± 25	± 25
Niobium-91	TBD	TBD	± 30	± 25	TBD	TBD	± 25	± 25
Plutonium	Pu-02	TBD	± 30	± 25	Pu-10	TBD	± 25	± 25
Plutonium-238	Pu-02	TBD	± 30	± 25	Pu-10	TBD	± 25	± 25
Plutonium-239/240	Pu-02	TBD	± 30	± 25	Pu-10	TBD	± 25	± 25
Plutonium-241	TBD	TBD	± 30	± 25	TBD	TBD	± 25	± 25
Polonium-210	TBD	TBD	± 30	± 25	TBD	TBD	± 25	± 25
Polonium-214	TBD	TBD	± 30	± 25	TBD	TBD	± 25	± 25
Polonium-218	TBD	TBD	± 30	± 25	TBD	TBD	± 25	± 25
Promethium-147	TBD	TBD	± 30	± 25	TBD	TBD	± 25	± 25
Protactinium-231	TBD	TBD	± 30	± 25	TBD	TBD	± 25	± 25
Radium-223	TBD	TBD	± 30	± 25	TBD	TBD	± 25	± 25
Radium-225	TBD	TBD	± 30	± 25	TBD	TBD	± 25	± 25
Radium-226	TBD	TBD	± 30	± 25	TBD	TBD	± 25	± 25
Radon-222	TBD	TBD	± 30	± 25	TBD	TBD	± 25	± 25

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Table 8-4. Data Quality Objective Parameters for Chemical/Radiochemical Analyses. (Sheet 3 of 5)

Radionuclides	Soil/Sediment				Water			
	Analysis ^{1/}	PQL ^{1/} in pCi/g	Precision ^{2/} in RPD	Accuracy ^{2/} in %	Analysis ^{1/}	PQL ^{1/} in pCi/L	Precision ^{2/} in RPD	Accuracy ^{2/} in %
Ruthenium-106	TBD	TBD	±30	±25	TBD	2.5	±25	±25
Strontium-90	Sr-02	TBD	±30	±25	Sr-02	TBD	±25	±25
Technetium-99	Tc-01 M	TBD	±30	±25	Tc-01	TBD	±25	±25
Thallium-207	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Thallium-209	TBD	TBD	±30	±25	TBD	300	±25	±25
Thorium-227	00-06	TBD	±30	±25	00-07	TBD	±25	±25
Thorium-229	00-06	TBD	±30	±25	00-07	TBD	±25	±25
Thorium-230	00-06	TBD	±30	±25	00-07	TBD	±25	±25
Thorium-231	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Thorium-234	TBD	TBD	±30	±25	TBD	300	±25	±25
Tritium	906.0 M	TBD	±30	±25	906.0	TBD	±25	±25
Uranium-233	U	TBD	±30	±25	908.0	TBD	±25	±25
Uranium-234	U	TBD	±30	±25	908.0	TBD	±25	±25
Uranium-235	U	TBD	±30	±25	908.0	TBD	±25	±25
Uranium-238	U	TBD	±30	±25	908.0	TBD	±25	±25
Yttrium-90	Sr-02	TBD	±30	±25	Sr-02	TBD	±25	±25

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Table 8-4. Data Quality Objective Parameters for Chemical/Radiochemical Analyses. (Sheet 4 of 5)

Inorganics	Soil/Sediment				Water			
	Analysis ^{1/}	PQL ^{1/} in mg/kg	Precision ^{2/} (RPD)	Accuracy ^{2/} (%)	Analysis ^{1/}	PQL ^{1/} in µg/L	Precision ^{2/} (RPD)	Accuracy ^{2/} (%)
pH	9045	N/A	N/A	N/A	9040	N/A	N/A	N/A
Ammonia	350.2 M	500	±25	±30	350.2	500	±20	±25
Barium	6010	0.02	±25	±30	6010	20	±20	±25
Bismuth	TBD	TBD	±25	±30	TBD	TBD	±20	±25
Boron	6010	TBD	±25	±30	6010	TBD	±20	±25
Cadmium	6010	0.09	±25	±30	6010	1	±20	±25
Chromium	6010	0.07	±25	±30	6010	10	±20	±25
Copper	6010	0.06	±25	±30	220.2	10	±20	±25
Fluoride	300 M	TBD	±25	±30	300	50	±20	±25
Hydrazine	TBD	TBD	±25	±30	TBD	TBD	±20	±25
Iron	6010	20	±25	±30	6010	70	±20	±25
Lead	6010	0.45	±25	±30	6010	450	±20	±25
Manganese	6010	0.02	±25	±30	6010	20	±20	±25
Molybdenum	6010	0.08	±25	±30	6010	80	±20	±25
Nickel	6010	1.5	±25	±30	6010	50	±20	±25
Nitrate	300 M	TBD	±25	±30	300	130	±20	±25
Nitrite	300 M	TBD	±25	±30	300	40	±20	±25
Palladium	TBD	TBD	±25	±30	TBD	TBD	±20	±25
Silver	6010	0.07	±25	±30	6010	70	±20	±25
Zinc	6010	0.02	±25	±30	6010	20	±20	±25

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Table 8-4. Data Quality Objective Parameters for Chemical/Radiochemical Analyses. (Sheet 5 of 5)

Organics	Soil/Sediment				Water			
	Analysis ^{1/}	PQL ^{1/} in mg/kg	Precision ^{2/} (RPD)	Accuracy ^{2/} (%)	Analysis ^{1/}	PQL ^{1/} in µg/L	Precision ^{2/} (RPD)	Accuracy ^{2/} (%)
1-Butanol	TBD	TBD	±35	±30	TBD	TBD	±30	±25
Chloroform	8240	0.005	±25	±30	8240	5	±20	±25
MIBK	8240	0.5	±25	±30	8240	5	±20	±25
Tributyl phosphate	TBD	TBD	±35	±30	TBD	TBD	±30	±25

TBD = To Be Determined

M = EPA method modified to include extraction from the solid medium, extraction method is matrix- and laboratory-specific.

^{1/} Prescribed Procedures for Measurements of Radioactivity in Drinking Water (EPA 1980)

Test Methods for Evaluation of Solid Waste (SW 846) Third Edition (EPA 1986)

Methods for Chemical Analysis of Water and Waste (EPA 1983)

^{2/} Precision and accuracy are goals. Since these parameters are highly matrix dependent they could vary greatly from the goals listed.

Table 8-5. Data Gaps by Site Category.

Site Category	Identified Data Gaps
Plants, Buildings and Storage Areas	<ul style="list-style-type: none"> • Surface radiation levels • Contents of tanks • Integrity of tanks
Tanks and Vaults	<ul style="list-style-type: none"> • Contaminant concentrations in wastes • Distribution of contaminants in subsurface soils, if leaks have occurred • Constituent concentrations in related surface contamination
Cribs and Drains	<ul style="list-style-type: none"> • Contaminant concentrations in soils in and beneath cribs • Specific constituents (especially organic chemicals) • Distribution and vertical/lateral extent of contamination
Reverse Wells	<ul style="list-style-type: none"> • Contaminant concentrations in subsurface soils impacted by discharges • Specific constituents (especially organics) • Extent of contamination
Ponds, Ditches, and Trenches	<ul style="list-style-type: none"> • Identity of contaminants • Surface water concentrations • Distribution/extent of contamination in sediments • Buried contaminant concentrations in stabilized portions/units
Septic Tanks and Associated Drain Fields	<ul style="list-style-type: none"> • Actual discharge levels • Possible discharge and presence/level of non-sanitary wastes (e.g., laboratory drains)
Transfer Facilities, Diversion Boxes, and Pipelines	<ul style="list-style-type: none"> • Identity and concentrations of contaminants • Direct radiation levels in facilities • Constituents/concentrations in related surface contamination • Integrity of transfer lines
Unplanned Releases	<ul style="list-style-type: none"> • Surface soil constituents and concentrations • Buried contamination constituents and concentrations

Table 8-6. Applicable Characterization Methods at Semi-Works Aggregate Area Waste Management Units. (Sheet 1 of 2)

Waste Management Unit	Surface Radiation Survey	Subsurface Geophysics*	Surface Geophysics (EM/GPR)	Soil Gas Survey	Surface Soil Sampling	Wipe Samples	Subsurface Soil Sampling	Surface Water Sediment Sampling	Remarks
Plants, Buildings, and Storage Areas									
201-C Process Building		•							
291-C Ventilation System		•							
Tanks and Vaults									
241-CX-70 Storage Tank	•	•					•		
241-CX-71 Storage Tank	•	•					•		
241-CX-72 Storage Tank	•	•					•		
Cribs and Drains									
216-C-1 Crib		A		A			A		Analogous Crib Site
216-C-3 Crib			•						Analogous Crib Site
216-C-4 Crib									Analogous Crib Site
216-C-5 Crib									Analogous Crib Site
216-C-6 Crib			•						Analogous Crib Site
216-C-7 Crib									Analogous Crib Site
216-C-10 Crib									Analogous Crib Site
Reverse Wells									
216-C-2 Reverse Well		•					•		
Ponds, Ditches, and Trenches									
216-C-9 Pond		•					•		
200 East Powerhouse Ditch	•	•					•	•	
Septic Tanks and Associated Drain Fields									

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Table 8-6. Applicable Characterization Methods at Semi-Works Aggregate Area Waste Management Units. (Sheet 2 of 2)

Waste Management Unit	Surface Radiation Survey	Subsurface Geophysics*	Surface Geophysics (EM/GPR)	Soil Gas Survey	Surface Soil Sampling	Wipe Samples	Subsurface Soil Sampling	Surface Water Sediment Sampling	Remarks
2607-E-5 Septic Tank and Drain Field	•	•					•		
2607-E-7A Septic Tank and Drain Field	•	•					•		
Transfer Facilities, Diversion Boxes, and Pipelines									
Semi-Works Valve Pit	•	•				•	•		
Critical Mass Laboratory Valve Pit	•				•	•	•		
241-C-154 Diversion Box	•	•				•	•		
Burial Sites									
218-C-9 Burial Ground		•	•		•		•		
Unplanned Releases									
UN-200-E-36									
UN-200-E-37	•				•		•		
UN-200-E-98	•				•		•		
UN-200-E-141	•					•			

Notes:

* Might require well installation due to lack of monitoring wells in Semi-Works Aggregate Area.

A - Representative analogue site for investigation of analogous units in this waste management unit category.

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9.0 RECOMMENDATIONS

The purpose of the AAMS is to compile and evaluate the existing body of knowledge to support the *Hanford Site Past-Practice Strategy* (DOE/RL 1992) decision-making process. A primary task in achieving this purpose is to assess each waste management unit and unplanned release within the aggregate area to determine the most expeditious path for remediation within the statutory requirements of the CERCLA and RCRA. The existing body of pertinent knowledge regarding Semi-Works Aggregate Area waste management units and unplanned releases has been summarized and evaluated in the previous sections of this report. A data evaluation process has been established that uses the existing data to develop preliminary recommendations on the appropriate remediation path for each waste management unit or unplanned release. This data evaluation process is a refinement of the *Hanford Site Past-Practice Strategy* (Figure 1-2) and establishes criteria for selecting the appropriate *Hanford Site Past-Practice Strategy* path (ERA, IRM, LFI, and final remedy selection) for individual waste management units and unplanned releases within the 200 Areas. A discussion of the criteria for path selection and the results of the data evaluation process are provided in Sections 9.1 and 9.2, respectively. Figure 9-1 provides a flowchart of the data evaluation process that will be discussed. Table 9-1 provides a summary of the results of the data evaluation assessment of each unit. Table 9-2 provides the decisional matrix patterns each unit followed.

This section presents recommended assessment paths for the waste management units and unplanned releases at the Semi-Works Aggregate Area. These recommendations are only proposed at this time and are subject to adjustment and change. Factors that may affect development of final recommendations include, but are not limited to, comments and advice from the EPA, Ecology, or DOE; identification and development of new information; and modification of the criteria used in the assessment path decision-making process. The data evaluation process depicted on Figure 9-1 and discussed in Section 9.1 was developed to facilitate only the technical data evaluation step shown on the *Hanford Site Past-Practice Strategy* (Figure 1-2). Procedural and administrative requirements for implementation of the recommendations provided in this AAMS will be performed in accordance with the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1990) and the *Hanford Site Past-Practice Strategy* (DOE/RL 1992). Changes in recommendations will be addressed and more detail on recommended assessment paths for waste management units and unplanned releases will be included in work plans as they are developed for the actual investigation and remediation activities.

1 Seven IRM candidate waste management units and unplanned releases do not
2 have sufficient information regarding the nature and extent of contamination for
3 quantitative or qualitative risk assessment, especially with regard to hazardous
4 constituents, and were recommended for additional investigation (e.g., LFI). No units
5 were recommended for an ERA. Four waste management units will be decontaminated,
6 decommissioned, and closed under other programs; these units were retained for
7 evaluation for final disposition under the AAMS following final decommissioning and
8 closure. Eighteen waste management units and unplanned releases were recommended
9 solely for the Final Remedy Selection Path. One of these, an unplanned release, is
10 recommended for a RA; the other seventeen are recommended for a RI.

11
12 A discussion of the four decision-making paths shown on Figure 9-1 (ERA, IRM,
13 LFI, and Final Remedy Selection) is provided in Section 9.1. Section 9.2 provides a
14 discussion of the waste management units and unplanned releases grouped under each of
15 these paths. A discussion of regrouping and prioritization of the waste management units
16 and unplanned releases is provided in Section 9.3. No additional aggregate area-based
17 field characterization activities are recommended to be undertaken as a continuation of
18 the AAMS. All recommendations for future characterization needs, as discussed in
19 Section 8.0, will be more fully developed and implemented through work plans. Plan
20 development and submittal will be accomplished in accordance with requirements of the
21 *Hanford Site Past-Practice Strategy* and the Tri-Party Agreement (Ecology et al. 1990) and
22 could include RI/FS, RFI/CMS, or LFI work plans. Sections 9.4 and 9.5 provide
23 recommendations for focused feasibility and treatability studies, respectively.

24 25 26 9.1 DECISION-MAKING CRITERIA

27
28 The criteria used to assess the most expeditious remediation process path are
29 based primarily on urgency for action and whether site data are adequate to proceed
30 along a given path (Figure 9-1). All waste management units and unplanned releases
31 that are not completely addressed under other Hanford Site programs are assessed in the
32 data evaluation process. All of the waste management units and unplanned releases that
33 are addressed in the data evaluation process are initially evaluated as candidates for an
34 ERA. Sites where a release has occurred or is imminent are considered candidates for
35 ERAs. Conditions that might trigger an ERA are the determination of an unacceptable
36 health or environmental risk or a short time-frame available to mitigate the problem
37 (DOE/RL 1992). As a result, candidate ERA units were evaluated against a set of
38 criteria to determine whether potential for exposure to unacceptable health or
39 environmental risks exists. Waste management units and unplanned releases that are
40 recommended for ERAs will undergo a formal evaluation following the selection process
41 outlined in *Prioritizing Sites for Expedited Response Actions at the Hanford Site* (WHC
42 1991b).

Waste management units and unplanned releases that are not recommended for consideration as an ERA continue through the data evaluation process. Sites continuing through the process that potentially pose a high risk, as identified in Section 5.0, become candidates for consideration as an IRM. The criteria used to determine a potential for high risk, thereby indicating a high priority site, were the HRS score used for nominating waste management units for CERCLA cleanup (40 CFR 300), the mHRS scores, surface radiation survey data, and rankings by the Environmental Protection Program (Huckfeldt 1991). Waste management units and unplanned releases with HRS or mHRS scores greater than 28.5 (the CERCLA cleanup criterion) were designated as candidate sites for IRM consideration. Waste management units and unplanned releases that did not have an HRS score were compared to similar sites to establish an estimated HRS score. Sites with surface contamination greater than 2 mrem/hr exposure rate, 100 ct/min beta/gamma above background, or alpha greater than 20 ct/min were also designated as candidate IRM sites. In addition, surface contamination which had an Environmental Protection Program ranking of greater than 7 were also designated as candidate IRM sites (rankings according to the Environmental Protection Program were not available for any of the Semi-Works Aggregate Area waste management units). The candidate IRM sites are listed in Table 5-1, which summarizes the high priority sites. The four risk indicators are based on limited data, as discussed in Section 8.0, and therefore may not adequately represent the actual risk posed by the site. Technical judgment, including assessment of similarities in site operational histories, was used to include waste management units and unplanned releases not ranked as high priority in the list of sites under consideration for an IRM. Candidate IRM sites were then further evaluated to determine if an IRM is appropriate for the site. Candidate IRM sites that did not meet the IRM criteria were placed into the final remedy selection path. As future data become available the list of waste management units and unplanned releases recommended for consideration as IRM sites may be altered.

For certain waste management units and unplanned releases, it was recognized that remedial actions could be undertaken under an existing operational or other Hanford Site program (e.g., RARA, Defense Waste Management, or Surplus Facilities programs). As a result, recommendations were made that remedial actions be undertaken (partially or completely) outside the AAMS past practice program. Waste management units or unplanned releases that could be addressed only in part by another program (e.g., surface contamination cleanup under the RARA program) remained in the AAMS data evaluation process for further consideration. If it cannot be demonstrated that these waste management units or unplanned releases will be addressed under the operational program within a time frame compatible with the past practice program, they will be readdressed by the AAMS process.

Waste management units and unplanned releases recommended for complete disposition under another program (e.g., single-shell tanks and associated structures

under the Single-Shell Tank program) were not considered in the AAMS data evaluation process. In addition, potentially new waste management units or unplanned releases that were identified during the AAMS were also not considered. It is recommended that a formal determination be made regarding the regulatory status of all new waste management units or unplanned releases following established procedures before they are considered further under the AAMS data evaluation process. Potentially new waste management units or unplanned releases identified in the Semi-Works Aggregate Area included four drains/dry wells and two unplanned releases, as described in Sections 2.3.3 and 2.3.10, respectively.

Specific criteria used to develop initial recommendations for ERAs, LFI, and IRMs for waste management units and unplanned releases within the aggregate area are provided in Sections 9.1.1 and 9.1.2. Waste management units and unplanned releases not initially addressed under an ERA, LFI, or IRM will be evaluated under the final remedy selection path discussed in Section 9.1.3.

9.1.1 Expedited Response Action Path

Candidate ERA sites are evaluated for unacceptable health or environmental risk and whether adequate time is available to mitigate the problem. All waste management units and unplanned releases other than those recommended for complete disposition under another Hanford program are assessed against the ERA criteria. The *Hanford Site Past-Practice Strategy* describes conditions that might trigger abatement of a candidate waste management unit or unplanned release under an ERA. Generally, these conditions would rely on a determination of, or suspected, existing or future unacceptable health or environmental risk, and a short time-frame available to mitigate the problem. Conditions include, but are not limited to the following:

- Actual or potential exposure to nearby human populations, biota, or the food chain from hazardous substances and radioactive or mixed waste contaminants
- Actual or potential contamination of drinking water supplies or sensitive ecosystems
- Threats of release of hazardous substances and radioactive or mixed waste contaminants
- High levels of hazardous substances and radioactive or mixed waste contaminants in soils that pose or may pose a threat to human health or the environment, or have the potential for migration

- Weather conditions that may increase the potential for release or migration of hazardous substances and radioactive or mixed waste contaminants
- The availability of other appropriate federal or state response mechanisms to respond to the release
- Time required to develop and implement a final remedy
- Further degradation of the medium which may occur if a response action is not expeditiously initiated
- Risks of fire or explosion or potential for exposure as a result of an accident or failure of a container or handling system
- Other situations or factors that may pose threats to human health or welfare or the environment.

These conditions were used as the initial screening criteria to identify candidate waste management units and unplanned releases for ERAs. Candidate waste management units and unplanned releases that did not meet these conditions were not assessed through the ERA evaluation path. Additional criteria for further, detailed screening of ERA candidates were developed based on the conditions outlined in the *Hanford Site Past-Practice Strategy*. These criteria were quantified for further screening. These screening criteria are shown on Figure 9-1 and are described below.

The next decision point on Figure 9-1 used to assess each ERA candidate is whether a driving force to an exposure pathway exists or is likely to exist. Waste management units or unplanned releases with contamination that is migrating or is likely to significantly migrate to a medium that can result in exposure and harm to humans required additional assessment under the ERA process. Waste management units or unplanned releases where contamination could migrate and, therefore, potentially require significantly more extensive remedial action if left unabated were also assessed in the ERA path.

Waste management units and unplanned releases with a driving force were assessed to determine if unacceptable health or environmental risk and a short time-frame available to mitigate the problem exists from the release. The criteria used to determine unacceptable risks are based on the quantity and concentration of the release. If the release or imminent release is greater than 100 times the CERCLA reportable quantity for any constituent, the waste management unit or unplanned release remains in consideration for an ERA. If the release or imminent release contains hazardous constituents at concentrations that are 100 times the most applicable standard, the waste

management unit or unplanned release continues to be considered for an ERA. Application of the criterion of 100 times applicable standards is for quantification of the strategy criteria which addresses "high levels of hazardous substances and radioactive or mixed waste contaminants. . ." The factor of 100 is based on engineering judgment of what constitutes a high level of contamination warranting expedited action. In some cases, engineering judgment was used to estimate the quantity and concentration of a postulated release. Standards applied include Model Toxics Control Act (MTCA) standards for industrial sites and DOE and Westinghouse Hanford Company radiation criteria (refer to Section 6.0). The application of these standards does not signify they are recognized as ARARs.

The ERA screening criteria, in addition to those presented in the *Hanford Site Past-Practice Strategy*, were applied to provide a consistent quantitative basis for making recommendations in this AAMS. The decision to implement the recommendations developed in this AAMS will be made collectively between DOE, EPA, and Ecology based only on the criteria established in the *Hanford Site Past-Practice Strategy*.

If a release is unacceptable with respect to health or environmental risk, a technology must be readily available to control the release for a waste management unit or unplanned release to be considered for an ERA. An example that would require substantial technology development before implementation of cleanup would be a tritium release since no established treatment technology is available to separate low concentrations of tritium from water.

The next step in the ERA evaluation path involves determining whether implementation of the available technology would have adverse consequences that would offset the benefits of an ERA. Examples of adverse consequences include: (1) use of technologies that result in risks to cleanup personnel that are much greater than the risks of the release; (2) the ERA would foreclose future remedial actions; and (3) the ERA would prevent or greatly hinder future data collection activities. If adverse consequences are not expected, the site remains in consideration for an ERA.

The final criterion is to determine if the candidate ERA is within the scope of an operational program. Maintenance and operation of active waste management facilities are within the scope of activities administered by the Defense Waste Management Program. Active facilities include certain transfer lines, diversion boxes, and the 200 East Powerhouse Ditch. Generally, active facilities will not be included in past practice investigations unless operation is discontinued prior to initiation of the investigation. The Surplus Facilities and RCRA Closures programs are responsible for safe and cost-effective surveillance, maintenance, and decommissioning of surplus facilities and RCRA closures at the Hanford Site. The Surplus Facilities program is also responsible for RARA activities that include surveillance, maintenance, decontamination, and/or

1 stabilization of inactive burial grounds, cribs, ponds, trenches, and unplanned release
2 sites.

3
4 If the proposed ERA will not address all the contamination present, the waste
5 management unit or unplanned release continues through the process to be evaluated
6 under a second path. For example, surface contamination cleanup under the RARA
7 program may not address subsurface contamination and, therefore, additional
8 investigation may be needed.

9
10 Final decision regarding the conduct of ERAs in the Semi-Works Aggregate Area
11 will be made among DOE, EPA, and Ecology based, at least in part, on the
12 recommendations provided in this section, and results of the final selection process
13 outlined in *Prioritizing Site for Expedited Response Actions at the Hanford Site* (WHC
14 1991b).

15 16 17 **9.1.2 Limited Field Investigation and Interim Remedial Measure Paths**

18
19 High priority waste management units and unplanned release sites were evaluated
20 to determine if sufficient need and information exist in order that an IRM could be
21 pursued. An IRM is desired for high priority waste management units and unplanned
22 releases where extensive characterization is not necessary to reach defensible cleanup
23 decisions. Implementation of IRMs at waste management units and unplanned releases
24 with minimal characterization is expected to rely on observational data acquired during
25 remedial activities. Successful execution of this strategy is expected to reduce both time
26 and cost for cleanup of waste management units and unplanned releases without
27 impacting the effectiveness of the implemented action.

28
29 The initial step in the IRM evaluation path is to categorize the waste management
30 units and unplanned releases. The exposure pathways of interest are similar for each
31 unit or release in a category; therefore, it is effective to evaluate candidate units or
32 releases as a group. The groupings used in Section 2.3 (e.g., cribs; tanks and vaults; etc.)
33 will continue to be used to group the waste management units and unplanned releases
34 for IRM assessment. This grouping approach is especially effective in reducing
35 characterization requirements. The LFIs can be used to characterize a representative
36 unit or units in detail to develop a remedial alternative for the group of units.
37 Observational data obtained during implementation of the remedial alternative could be
38 used to meet unit-specific needs. Similarities of waste management units may make it
39 possible to remediate them using the observational approach after first characterizing
40 only a few units. It is expected, therefore, that a LFI would provide sufficient
41 information to proceed with an IRM for groups of similar high priority waste

1 management units. This methodology is consistent with the approaches outlined in the
2 *Hanford Site Past-Practice Strategy*.

3
4 Data adequacy is assessed in the next step. The existing data are evaluated to
5 determine if: (1) existing data are sufficient to develop a conceptual model and
6 qualitative risk assessment; (2) the IRM will work for this pathway; (3) implementing the
7 IRM will have adverse impacts on the environment, future remediation activities, or data
8 collection efforts; (4) the benefits of implementing the IRM are greater than the costs. If
9 data are not adequate an assessment is made to determine if a LFI might provide
10 enough data to perform an IRM. If a LFI would not collect sufficient data to perform
11 an IRM, the waste management unit is addressed in the final remedy selection path.

12
13 The final step in the IRM evaluation process is to assess if the IRM will work
14 without significant adverse consequences. This includes: will the IRM be successful? will
15 it create significant adverse environmental impacts (e.g., environmental releases)? will the
16 costs outweigh the benefits? will it preclude future cleanup or data collection efforts? and
17 will the risks of the cleanup be greater than the risks of no action? Waste management
18 units or unplanned releases where remediation is considered to be possible without
19 adverse consequences outweighing benefits of the remediation are recommended for
20 IRMs.

21
22 The scope of this study is limited to the Semi-Works Aggregate Area and it is
23 assumed that LFI/IRM activities will be implemented via the operable unit-based work
24 plans. As comprehensive planning for the entire NPL site is refined, it may be
25 determined that the scope of work plans could be based on analogous waste
26 management unit groups regardless of existing operable unit boundaries.

27
28 Final decisions will be made among DOE, EPA, and Ecology regarding the
29 conduct of IRMs in the Semi-Works Aggregate Area based, at least in part, on the
30 recommendations provided in this AAMS, and the results of a supporting LFI.

31 32 33 **9.1.3 Final Remedy Selection Path**

34
35 Waste management units recommended for initial consideration in the Final
36 Remedy Selection Path are those not recommended for IRMs, LFIs, or ERAs and those
37 considered to be low priority sites. It is recognized that all waste management units and
38 unplanned releases within the operable unit or aggregate area will eventually be
39 addressed collectively under the Final Remedy Selection Path to support a final ROD.

40
41 The initial step in the Final Remedy Selection Path is to assess whether the
42 combined data from the AAMS, and any completed ERAs, IRMs, and LFIs are

adequate for performing a risk assessment (RA) and selecting a final remedy. Whereas the scope of an ERA, IRM, and LFI is limited to individual waste management units or groups of similar waste management units, the Final Remedy Selection Path will likely address an entire operable unit or aggregate area.

If the data are collectively sufficient, an operable unit or aggregate area RA will be performed. If sufficient data are not available, additional needs will be identified and collected.

9.2 PATH RECOMMENDATIONS

Initial recommendations for ERA, IRM, and LFI are discussed in Section 9.2.1 through 9.2.3, respectively. Waste management units and unplanned releases proposed for initial consideration under the Final Remedy Selection Path are discussed in Section 9.2.4. Table 9-1 provides a summary of the data evaluation process path assessment. A summary of the responses to the decision points on the flowchart that led to the recommendations are provided in Table 9-2. Following approval by DOE, EPA, and Ecology, these recommendations will be further developed and implemented in work plans.

9.2.1 Proposed Sites for Expedited Response Actions

None of the twenty-five waste management units and unplanned releases addressed in the Semi-Works Aggregate Area screening process met all the criteria for the ERA path. Twelve of the waste management units and unplanned releases met the criteria for the initial step in the ERA path, as indicated on Table 9-2 (i.e., the *Hanford Site Past-Practices Strategy* criteria).

The 216-C-2 Reverse Well and the Critical Mass Laboratory Valve Pit were not recommended for ERAs because of the lack of evidence of existing releases of contaminants. The 216-C-1, 216-C-3, 216-C-4, 216-C-5, 216-C-6, 216-C-7, and 216-C-10 Cribs, the 216-C-9 Pond, and Unplanned Releases UN-200-E-98 and UN-200-E-141 were not recommended for ERAs because of the lack of driving force to an exposure pathway.

9.2.2 Proposed Sites for Interim Remedial Measures

Seven waste management units were considered candidates for IRMs. With the exception of having adequate data, these waste management units either met the criteria for IRM designation, or were grouped with similar or nearby units or releases which did

1 meet the criteria. Although the available data are not adequate to proceed directly into
2 an IRM, it was determined that a LFI could gather sufficient data to assess future
3 options. Consequently these units remain IRM candidates.

4
5 Section 9.2.2.1 discusses the high priority designation within the context of the
6 IRM process. Section 9.2.2.2 presents a consideration of the available data for high
7 priority sites and discusses whether they are adequate to perform an IRM.

8
9 **9.2.2.1 High Priority Sites.** Initially, two of the twenty-five waste management units and
10 unplanned releases addressed in the Semi-Works Aggregate Area data evaluation process
11 were identified as high priority units (refer to Section 5.4). The 216-C-1 and 216-C-10
12 Cribs were designated as high priority units because of high HRS and mHRS scores.

13
14 The 216-C-1 Crib is a concrete vault type crib which received a HRS score of
15 50.34. The 216-C-10 Crib is a drain-field type crib which received a HRS score of 47.82.
16 The remaining five cribs (216-C-3, 216-C-4, 216-C-5, 216-C-6, and 216-C-7) at the Semi-
17 Works Aggregate Area are also drain field-type cribs of generally similar construction to
18 the 216-C-10 Crib. Based on a limited amount of available data, these five inactive cribs
19 received relatively low (<2) HRS scores. Due to their similarities to the high priority
20 cribs in construction, operational history, and general proximity, they were conservatively
21 evaluated as high priority sites under the IRM path.

22
23 **9.2.2.2 Data Adequacy.** No direct sampling information exists for the seven cribs that
24 are candidates for the IRM path. It was determined that LFIs could gather sufficient
25 data for the cribs, and therefore they should remain IRM candidates. A discussion of the
26 LFIs is provided in Section 9.2.3.

27 28 29 **9.2.3 Proposed Sites for Limited Field Investigation Activities**

30
31 Seven waste management units are recommended to undergo LFIs. The rationale
32 and scope of the LFIs will be defined and implemented via work plans; however, the
33 following addresses possible considerations for work plan development.

34
35 Possible LFI objectives would be as follows:

- 36
37 • Evaluate the potential for releases from the waste management unit to
38 impact underlying groundwater quality
- 39
40 • Determine if contamination exists at the surface of the waste management
41 units and unplanned releases, and if so, assess the extent
- 42

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- Determine if contamination exists in the soil beneath the waste management units and unplanned releases, and if so, assess the extent
- Assess the nature and extent of contaminant migration from the waste management units and unplanned releases in support of focused feasibility studies.

Although LFIs have been identified for individual waste management units (see Table 9-1), LFIs will actually be implemented in groups. In most cases these LFI groups will be consistent with the waste management unit groups established in Section 2.3 which were based on similarities in construction, function, and/or origin. For example, all cribs within an operable unit will likely be investigated under a single crib LFI.

It is expected that work plan strategies will also maximize the use of the analogous site concept discussed in the *Hanford Site Past-Practice Strategy*. This concept emphasizes that characterization activities can be reduced by identifying select sites (analogue sites) for characterization that are representative of a group of sites (analogous groups). This concept is particularly applicable to operable units which often contain a number of sites that are similar in design, disposal history, and geology. Appropriate confirmatory characterization, as necessary to support remedial action, can then be performed at the sites within each analogous group during remediation. Collection of confirmatory data can again be reduced during remediation activities by emphasizing use of the observational approach in work plans, as discussed in the *Hanford Site Past-Practice Strategy*.

To facilitate the implementation of these strategies in work plans, individual LFIs were assembled into analogous groups for operable units within an aggregate area. Specific waste management units and unplanned releases were then identified that were considered to be representative of the analogous groups. Considerations used to select an analogue site for an analogous group include, but are not limited to, the following:

- Disposal history (including type and quantity of waste received)
- Physical and chemical setting

Generally the selection process favored as analogue sites those units or releases that received the most waste and were considered as conservative examples in terms of release mechanisms, media of concern, exposure routes, and receptors.

1 Candidate IRM waste management units for which LFIs have been recommended
2 for the Semi-Works Aggregate Area have been categorized into one analogous group
3 that contains all seven cribs (216-C-1, 216-C-3, 216-C-4, 216-C-5, 216-C-6, 216-C-7, and
4 216-C-10). An analogue site (216-C-1 Crib) has been selected from this analogous group
5 for possible consideration during work plan development. Site-specific rationale for this
6 analogous group and the proposed analogue site are provided below.

7
8 Six of the cribs being evaluated as high priority under the IRM path were
9 associated with and located south of the 201-C Process Building and its support
10 buildings. These include the following:

- 11 • 216-C-1 Crib
- 12 • 216-C-3 Crib
- 13 • 216-C-4 Crib
- 14 • 216-C-5 Crib
- 15 • 216-C-6 Crib
- 16 • 216-C-10 Crib.

17
18 The 216-C-7 Crib, which is being evaluated as a high priority under the IRM path,
19 is associated with and located south of the Critical Mass Laboratory.

20
21 The second decision point (following the criteria for designation as high priority)
22 in the IRM path is to assess whether data are adequate to conduct an IRM. The data
23 available for the cribs are screening level data and estimated inventories which do not
24 provide information on the nature and extent of the contamination. Therefore, an IRM
25 could not be implemented without further investigation. All seven cribs are
26 recommended for LFI activities as described below.

27
28 The 216-C-1, 216-C-3, 216-C-4, 216-C-5, and 216-C-6 Cribs are proposed as an
29 analogous group due to their similar operational history (operated during REDOX and
30 PUREX processes), waste stream received (low to high salt, neutral to basic process
31 waste and cold-run waste), and location (within 183 m [600 feet] of each other).

32
33 The physical and chemical setting for releases from these waste management units
34 is also similar:

- 1 • Relatively large-scale liquid releases (37,900 to 23,400,000 liters) occurred
2 at these waste management units likely affecting near-surface and deeper
3 vadose zone soils.
4
- 5 • The waste management units were completed to roughly the same depths
6 and thus are likely completed in the same stratigraphic horizon. Likewise,
7 the depth to groundwater, approximately 85 m (280 ft), is similar for all of
8 these waste management units.
9
- 10 • Semi-Works Aggregate Area stratigraphy, predominantly the Hanford
11 formation sand unit and the gravels of the Ringold Formation, is generally
12 uniform across the aggregate area and would tend to favor primarily
13 downward fluid movement with limited lateral spreading. Perched water is
14 possible, however, due to the presence of locally discontinuous paleosols in
15 the Hanford formation.
16
- 17 • The waste management units likely received wastewater containing organic
18 compounds such as TBP and also likely received some quantity of acidic
19 wastewater which can enhance the mobility of radionuclides and metals in
20 the subsurface. However, possibly due to microbial degradation, TBP does
21 not appear to persist in the subsurface at the Hanford Site. Also, because
22 Semi-Works was only a pilot-scale facility, the volume of acidic waste
23 disposed of to these cribs appears to be substantially less than that disposed
24 of to the subsurface at production facilities such as the RECUPLEX facility
25 in the Z Plant Aggregate Area.
26

27 The 216-C-1 Crib is proposed as an analogue LFI site for the 216-C-3, 216-C-4,
28 216-C-5, and 216-C-6 Cribs. The 216-C-1 Crib received the largest volume of waste in
29 the group (23,400,000 liters) and had the largest reported inventory of total plutonium
30 and uranium (8 gm and 0.099 ci, respectively). In addition, the time of performance of
31 the 216-C-1 Crib (1953 to 1957) overlaps the operating periods for the other four cribs.
32 Thus, the 216-C-1 Crib would be a conservative representative, with a common operating
33 history, for the other cribs in this analogous group.
34

35 The 216-C-1 Crib is also proposed as a partial analogue LFI site for the 216-C-7
36 and 216-C-10 Cribs. The inventory of waste volumes and radionuclides received by the
37 216-C-1 Crib compare to or exceed those received by the 216-C-7 and 216-C-10 Cribs.
38 The physical and chemical setting for releases from the 216-C-7 and 216-C-10 Cribs
39 would be basically similar to the physical and chemical setting described above for the
40 other cribs (including 216-C-1). Thus, the 216-C-1 Crib should be able to serve as an
41 analogue for the 216-C-7 and 216-C-10 Cribs in many areas, including contaminant
42 migration, exposure pathways, and impacts on groundwater.

1 A significant difference, related to the waste streams received, must be considered.
2 The 216-C-7 Crib received reflector tank water from the Critical Mass Laboratory. The
3 waste stream routed to the 216-C-10 Crib was primarily acidic organic waste from the
4 Strontium Recovery Process. Due to the potential presence of different contaminants,
5 the 216-C-1 Crib can only function as a partial analogue and additional LFI activities are
6 thus recommended for the 216-C-7 and 216-C-10 Crib as well. However, the goal of
7 these LFIs would only be to obtain supplemental data, specific to these cribs, that could
8 not be obtained during the 216-C-1 Crib LFI. The LFIs for the 216-C-7 and 216-C-10
9 Crib should focus on gathering information about the unique contaminants released to
10 the cribs and their migration in the environment. The data could then be used to
11 augment the information gathered from the 216-C-1 Crib LFI to determine if
12 opportunities for IRMs exist at all the cribs.

15 9.2.4 Proposed Sites for Final Remedy Selection Path

17 The remaining eighteen waste management units and unplanned releases are
18 proposed for the Final Remedy Selection Path. One of the unplanned releases had
19 sufficient information for inclusion in the final RA under the Final Remedy Selection
20 Path; Unplanned Release UN-200-E-36 is discussed in Section 9.2.4.1. Direct inclusion in
21 the final remedy selection RI is recommended for all of the remaining waste
22 management units and unplanned releases due to the lack of sufficient information to
23 perform a RA.

25 The RI recommended for the Semi-Works Aggregate Area includes several groups
26 of waste management units and unplanned releases. These are discussed in Sections
27 9.2.4.2 through 9.2.4.8, and are grouped as follows:

- 29 • 201-C Process Building, 291-C Ventilation System, 241-C-154 Diversion
30 Box, Semi-Works Valve Pit, and 216-C-2 Reverse Well
- 32 • 216-C-9 Pond and 218-C-9 Burial Ground
- 34 • Septic Tanks and Associated Drain Fields
- 36 • 241-CX-70, 241-CX-71, and 241-CX-72 Storage Tanks
- 38 • Unplanned Releases UN-200-E-37, UN-200-E-98 and UN-200-E-141
- 40 • Critical Mass Laboratory Valve Pit
- 42 • 200 East Powerhouse Ditch.

1 **9.2.4.1 Unplanned Release UN-200-E-36.** Cleanup actions were taken in 1967
2 immediately after Unplanned Release UN-200-E-36 occurred. Due to this and a lack of
3 detection in current surface radiation data, Unplanned Release UN-200-E-36 was
4 eliminated from the ERA path because it did not meet the *Hanford Site Past-Practice*
5 *Strategy* criteria. Unplanned Release UN-200-E-36 was not ranked as a high priority site
6 and consequently is not included in the IRM path. The release is recommended for a
7 RA. The available radiation data should result in a RA recommending no further action
8 is needed.

10 **9.2.4.2 201-C Process Building, 291-C Ventilation System, 241-C-154 Diversion Box,**
11 **Semi-Works Valve Pit, and 216-C-2 Reverse Well.** These five waste management units
12 are grouped together because they all underwent similar decommissioning techniques and
13 are in relative proximity to each other. All five waste management units are presently
14 located beneath a common, partially installed ash barrier.

16 The above-ground portions of the 201-C Process Building and the 291-C
17 Ventilation System structures were decontaminated, dismantled, rubble to the cell tops,
18 and/or sealed with grout. The underground portions of the structures were stabilized in
19 place by filling the voids with cement grout. The diversion box and valve pit were also
20 filled with grout.

22 Due to past decommissioning activities and the stabilization of in-place
23 contamination, the 201-C Process Building, 291-C Ventilation System, 241-C-154
24 Diversion Box, and Semi-Works Valve Pit were eliminated from the ERA path because
25 they do not meet the *Hanford Site Past-Practice Strategy* criteria. Similarly, these waste
26 management units were not ranked as high priority sites and consequently were not
27 included in the IRM path. A RI is recommended for these waste management units to
28 collect sufficient data to evaluate the limits under the overall RA for the operable
29 unit/aggregate area.

31 The 216-C-2 Reverse Well has been stabilized, grouted, and is under the partially
32 installed ash barrier. This unit was initially assessed in the ERA path, but was eliminated
33 in the screening process due to lack of a driving force to an exposure pathway. It was
34 not ranked as a high priority and thus was not assessed in the IRM path. Furthermore,
35 the data were insufficient to perform a RA in the Final Remedy Selection Path.
36 Consequently, a RI is recommended for the 216-C-2 Reverse Well to collect sufficient
37 data for the overall operable unit/aggregate area RA.

39 **9.2.4.3 216-C-9 Pond and 218-C-9 Burial Ground.** These two units are grouped together
40 due to their proximity. The 218-C-9 Burial Ground was situated in the eastern portion of
41 the 216-C-9 Pond, after use of the pond had ceased and it had largely dried up.

1 The 216-C-9 Pond was initially assessed in the ERA path. However, given that
2 the unit is inactive and has been stabilized with a gravel layer, it was eliminated from this
3 path because there is no longer a driving force to an exposure pathway. Since it was not
4 ranked a high priority site it was not assessed in the IRM path. Finally, there was
5 insufficient data to perform a RA for the unit.

6
7 The 218-C-9 Burial Ground did not meet the initial criteria for the ERA path, nor
8 was it considered a high priority site to be assessed in the IRM path. Again, due to a
9 limited amount of available data, a RA could not be performed.

10
11 Data for a RI, the recommended path for this group, can be collected
12 simultaneously for both waste management units. Subsequently, a RA can be performed
13 and a final remedy selected.

14
15 **9.2.4.4 Septic Tanks and Associated Drain Fields.** The 2607-E-5 and 2607-E-7A Septic
16 Tanks and Drain Fields have been grouped together not only because of their similarity,
17 but also because they work in tandem and share a common drain field. These active
18 waste management units are reported to receive only sanitary waste and, consequently,
19 did not meet the criteria for the ERA path. The units were not ranked as high priorities,
20 so they were not considered as candidates for IRMs. Insufficient site-specific sampling
21 and waste inventory data preclude moving immediately into the RA branch of the Final
22 Remedy Selection Path, so a RI is recommended. Investigation is recommended for
23 these two units to provide enough data to confirm that no contamination exists. If no
24 contamination were to be found, then no further action would be recommended.

25
26 **9.2.4.5 241-CX-70, 241-CX-71, and 241-CX-72 Storage Tanks.** These three tanks are
27 grouped together due to their proximity, similarity of wastes received, and general
28 similarity of design and construction.

29
30 These tanks are currently being addressed under the Hanford Surplus Facilities
31 and RCRA Programs. The 241-CX-70 Storage Tank has been cleaned and contains no
32 residual wastes. The 241-CX-71 Storage Tank should be cleaned within one to three
33 years, depending on the extent of engineering needed to remove and manage the tank
34 wastes. The 241-CX-72 Storage Tank may be cleaned within two to six years, depending
35 on funding and task assignments. Following decontamination and decommissioning of
36 the final tank, all three tanks will be closed under the RCRA Program. It will be
37 determined at that time whether the tanks can be clean closed or closed as landfills with
38 hazardous waste in place.

39
40 The 241-CX-70, 241-CX-71, and 241-CX-72 Storage Tanks were not considered to
41 be candidates for ERAs because they did not meet the criteria in the *Hanford Site Past-*
42 *Practice Strategy* for ERAs. They did not rank as high priority sites, so were not

1 considered candidates for IRMs. Thus, they were carried on for consideration under the
2 Final Remedy Selection Path. Since the decontamination and closure of the tanks are
3 being addressed by existing operational programs, tank closure activities should not be
4 supplanted by the AAMS process. However, final evaluation of the need for post-closure
5 care or remediation of the tanks would most reasonably be performed in conjunction
6 with the CERCLA investigation and remediation activities progressing for the Semi-
7 Works Aggregate Area.

8
9 Therefore, it is recommended that the 241-CX-70, 241-CX-71, and 241-CX-72
10 Storage Tanks be considered in the overall RA for the operable unit. Information
11 obtained during the tank closures as well as from other investigations at the Semi-Works
12 Aggregate Area would be integrated in the operable unit RI to provide any needed
13 information to perform a RA and recommend any further remediation needed for the
14 tanks.

15
16 **9.2.4.6 Unplanned Releases UN-200-E-37, UN-200-E-98, and UN-200-E-141.** These three
17 unplanned releases are grouped together because they involve surface releases of
18 radioactive contamination.

19
20 Unplanned Release UN-200-E-37 was created during remediation efforts for
21 Unplanned Release UN-200-E-36. It was not assessed in the ERA path because it did
22 not meet the necessary criteria in the *Hanford Site Past-Practice Strategy* for ERAs. The
23 unplanned release was not ranked a high priority and thus was not considered a
24 candidate for IRM. The available data are insufficient to perform a RA, therefore a RI
25 is recommended for Unplanned Release UN-200-E-37.

26
27 Unplanned Release UN-200-E-98 involved radioactive particulate matter and
28 occurred near the base of the 291-C Stack and around the 216-C-2 Reverse Well. It was
29 initially assessed in the ERA path. However, since the site had undergone cleanup and
30 had subsequently been covered with the ash barrier, there is no driving force to an
31 exposure pathway. Similarly, the unplanned release was not ranked as a high priority
32 and thus not included in the IRM path. A RI is recommended for the Unplanned
33 Release UN-200-E-98. A limited amount of additional data on this unplanned release is
34 needed to conduct a RA.

35
36 Unplanned Release UN-200-E-141 involved an uranyl nitrate spill in the 2718
37 Storage Building near the Critical Mass Laboratory. All contaminated materials,
38 including soil, were removed until background levels of contamination were encountered.
39 The site was assessed in the ERA path, but was eliminated due to a lack of a driving
40 force to an exposure pathway. The unplanned release was not included in the IRM path
41 because it was not ranked a high priority. A RI is recommended for Unplanned Release

UN-200-E-141 to confirm that the site was adequately remediated and provide data for a RA.

9.2.4.7 Critical Mass Laboratory Valve Pit. The Critical Mass Laboratory Valve Pit was, until recently, considered to be an active unit. The likely future status of the valve pit will be inactive, which will result in its decontamination and decommissioning under the Hanford Surplus Facilities Program. After the valve pit has been decommissioned, it will need to be finally considered under the Semi-Works AAMS process. Thus, even though decontamination of the valve pit will be performed under a separate program, it was evaluated under the ERA, IRM, and Final Remedy Selection Paths.

The Critical Mass Laboratory Valve Pit was assessed in the ERA path, but was eliminated due to a lack of a driving force to an exposure pathway. It did not rank as a high priority site, so was not considered a candidate for IRM. Thus, the valve pit was carried on for consideration under the Final Remedy Selection Path. The decontamination of the valve pit will be addressed by an existing operational program. Final evaluation of the need for further remediation within the overall context of the Semi-Works Aggregate Area activities will then be required.

It is recommended that the Critical Mass Laboratory Valve Pit be considered in the overall RA for the operable unit. Information obtained during decontamination and decommissioning as well as from other investigations at the Semi-Works Aggregate Area would be integrated in the operable unit RI to provide the needed information to perform a RA and recommend any further remediation needed for the valve pit.

9.2.4.8 200 East Powerhouse Ditch. The 200 East Powerhouse Ditch is currently an active waste management unit. However, discharges to the ditch will eventually be halted, at which time the ditch will need to be considered under the AAMS for potential investigation and remediation. Therefore, it was evaluated under the ERA, IRM, and Final Remedy Selection Paths.

The 200 East Powerhouse Ditch was not assessed in the ERA path because it did not meet the necessary criteria in the *Hanford Site Past-Practice Strategy* for ERAs. The ditch was not ranked a high priority and thus was not considered a candidate for IRM. The available data are insufficient to perform a RA, therefore a RI is recommended for the 200 East Powerhouse Ditch.

9.3 SOURCE OPERABLE UNIT REDEFINITION AND PRIORITIZATION

The investigation process can be made more efficient if waste management units with similar histories and waste constituents are studied together. The data needs and remedial actions required for similar waste management units are generally the same. It is much easier to ensure a consistent level of effort and investigation methodology if like units are grouped together. Economies of scale also make the investigation process more cost-effective if similar waste management units are studied together.

9.3.1 Units Addressed by Other Programs

During the course of the Semi-Works AAMS it was determined that four of the original twenty-five waste management units could be more appropriately addressed under other programs currently operating at the Hanford Site. These programs include the Hanford Surplus Facilities Program and RCRA Program. The following sections discuss the recommended programs for the four waste management units.

9.3.1.1 Hanford Surplus Facilities Program. Decontamination and decommissioning activities would be carried out for four waste management units under the Hanford Surplus Facilities Program. These units include the 241-CX-70, 241-CX-71, and 241-CX-72 Storage Tanks, and the Critical Mass Laboratory Valve Pit. However, further activities will be needed for each of these units following final decommissioning.

The storage tanks will have to be closed under the RCRA Program, as discussed further below. The Critical Mass Laboratory Valve Pit has been recommended for final assessment under the Final Remedy Selection Path for the operable unit once decommissioning has been completed. Under this recommended approach, it would be necessary to coordinate investigation and decontamination work performed for the valve pit under the Hanford Surplus Facilities Program with ongoing CERCLA activities at the Semi-Works Aggregate Area.

9.3.1.2 RCRA Program. The 241-CX-70, 241-CX-71, and 241-CX-72 Storage Tanks are currently being decontaminated and decommissioned under the Hanford Surplus Facilities Program. Following decommissioning, the tanks will be closed under the RCRA Program. Cleaning of the tank contents and closure of the tanks should remain under these programs.

However, it is recommended that final assessment of the need for post-closure care or remediation be incorporated into the Final Remedy Selection Path for the operable unit. Under this recommended approach, it would be necessary to coordinate

1 investigation and remediation work performed under the Hanford Surplus Facilities and
2 RCRA Programs with ongoing CERCLA activities at the Semi-Works Aggregate Area.

5 9.3.2 Semi-Works Operable Unit Redefinition

7 The Semi-Works Aggregate Area contains only one operable unit, 200-SO-1,
8 therefore there is no opportunity to consolidate operable units.

10 All of the waste management units and unplanned releases in the Semi-Works
11 Aggregate Area, with the exception of the 200 East Powerhouse Ditch, are associated
12 with past waste management practices at Semi-Works. The 200 East Powerhouse Ditch
13 is an active liquid waste disposal unit that is connected to the 216-B-3 Pond Complex in
14 the B Plant Aggregate Area. It is recommended that the 200 East Powerhouse Ditch be
15 redefined to be in the 200-SS-1 operable unit. None of the other Semi-Works Aggregate
16 Area waste management units and unplanned releases are recommended for
17 investigation or remediation under other aggregate areas or operable units.

19 Investigation of groundwater should be removed from the scope and included in a
20 200 East Area Groundwater Operable Unit. Groundwater beneath the 200-SO-1
21 Operable Unit interacts with all surrounding operable units since it is not confined by the
22 geographic boundaries. Contamination from nearby operable units has potentially
23 migrated beneath the 200-SO-1 Operable Unit. Similarly, the contamination originating
24 from the operable unit has potentially migrated outside the boundaries of the operable
25 unit. These interactions with other operable units will necessitate the integration of
26 groundwater response actions throughout the 200 East Area. This integration would
27 likely be best handled in groundwater-specific operable units, rather than in combined
28 groundwater and source operable units.

31 9.3.3 Investigation Prioritization

33 Very little if any data exist to rank the waste management units and unplanned
34 releases within the Semi-Works Aggregate Area on a risk-related basis. The HRS,
35 mHRS, and surface contamination data which were used to sort the waste management
36 units and unplanned releases into either high or low priority are indicators of potential
37 risk but are not necessarily suitable to develop a risk-related priority ranking. The most
38 useful data for indicating potential risk are probably a combination of the surface
39 radiation data and the waste inventories.

41 Given the volume of liquids received and the potential that some of this may have
42 reached the groundwater table (Table 4-14), the cribs and 216-C-9 Pond/218-C-9 Burial

1 Ground should be considered as higher priority sites. The cribs are recommended as
2 having a higher priority than the 216-C-9 Pond/218-C-9 Burial Ground. Although the
3 216-C-9 Pond received relatively large volumes of liquids, most of these were process
4 cooling waters that would not have contained the levels of contaminants present in the
5 crib discharges. The 218-C-9 Burial Ground received only dry demolition and
6 decommissioning wastes, thus is not likely to present as significant a threat of
7 contaminant migration as would the cribs. Of the cribs, the 216-C-1 Crib should be
8 investigated first as the analogue site for the other cribs, followed by investigation of the
9 216-C-7 and 216-C-10 Cribs.

10
11 In general, priorities for the remaining waste management units and unplanned
12 releases are not critical, and should be developed in subsequent work plans. However, it
13 should be noted that investigations of several units (the 241-CX-70, 241-CX-71, and 241-
14 CX-72 Storage Tanks, and the Critical Mass Laboratory Valve Pit) will be performed as
15 part of decontamination, decommissioning, and closure activities under the Hanford
16 Surplus Facilities and RCRA Programs. These activities should be given sufficient
17 priority within their respective programs to enable effective integration with final
18 evaluation of these units under the Final Remedy Selection Path for the Semi-Works
19 AAMS.

20 21 22 9.3.4 RCRA Facility Interface

23
24 One RCRA TSD facility is currently identified in the Semi-Works Aggregate
25 Area; the 241-CX-70 Storage Tank. A Part A for the 241-CX-71 Storage Tank will be
26 submitted to Ecology shortly. As soon as analytical data for the 241-CX-72 Storage Tank
27 contents are obtained, a Part A will be submitted to Ecology for this third tank as well.
28 All three tanks are currently considered to be subject to RCRA.

29
30 Following decontamination and decommissioning under the Hanford Surplus
31 Facilities Program, it is expected that all three storage tanks will be closed under the
32 RCRA Program. If the tanks are clean closed, it should be possible to remove them
33 from further consideration as waste management units. Pending concurrence from the
34 regulatory agencies, it may not be necessary to evaluate the tanks further under the
35 CERCLA process for the Semi-Works Aggregate Area.

36
37 If the storage tanks cannot be clean closed, it is recommended that the need for
38 post-closure care or remediation be addressed under the CERCLA process as part of the
39 Final Remedy Selection Path for the operable unit. The rationale for this
40 recommendation is based on the intent expressed in the *Hanford Site Past-Practice*
41 *Strategy* to integrate the CERCLA RI/FS and RCRA TSD Closure processes wherever
42 possible to avoid duplication of efforts. Since the processes are intended to support each

other, and all other work at the Semi-Works Aggregate Area would be performed under the CERCLA process, the storage tanks would most efficiently be addressed by incorporating them under the ongoing CERCLA investigation and remediation work. RCRA considerations would be addressed as ARARs under the CERCLA activities.

Implementing the above recommendations would require interfacing the Semi-Works AAMS process with the RCRA Program as the tanks are investigated and evaluated for permanent closure options. The RCRA closure and AAMS processes would identify opportunities to integrate their activities, including efforts to: select mutually supportive data quality objectives; coordinate data collection; and use compatible closure/remediation methods.

9.4 FEASIBILITY STUDY

Two types of the FS will be conducted to support remediation in the 200 Areas including focused and the final FS. Focused feasibility studies (FFSs) are studies in which a limited number of units or remedial alternatives are considered. A final FS will be prepared to provide the data necessary to support the preparation of final ROD. Insufficient data exist to prepare either a focused or final FS for any waste management units or group of units within the Semi-Works Aggregate Area. Sufficient data are considered available to prepare a FFS on selected remedial alternatives.

9.4.1 Focused Feasibility Study

Both LFI and IRMs are planned for the Semi-Works Aggregate Area for individual waste management units or waste management unit groups and unplanned releases. The IRMs will be implemented as they are approved, and the FFS will be prepared to support their implementation. The FFS applied in this manner is intended to examine a limited number of alternatives for a specific waste management unit or group of waste management units. The FFS supporting IRMs will be based on the technology screening process applied in Section 7.0, engineering judgement, and/or new characterization data such as that generated by a LFI.

Recommendations for the FFS in support of IRMs are not provided in this report because of the limited data availability. In all cases, LFIs will be conducted at sites initially identified for IRMs. The information gathered is considered necessary prior to making a final determination whether an IRM is actually necessary or whether a remedy can be selected.

1 Rather than being driven by an IRM, the FFS will also be prepared to evaluate
2 select remedial alternatives. In this case the FFS focuses on technologies or alternatives
3 that are considered to be viable based on their implementability, cost, and effectiveness
4 and have broad application to a variety of sites. The following recommendations are
5 made for FFSs that focus on a particular technology or alternative:

- 6
- 7 • Capping
- 8
- 9 • Ex situ treatment of contaminated soils
- 10
- 11 • In situ stabilization.
- 12

13 These recommendations reflect select technologies developed in Section 7.0 of this
14 report.

15
16 The FFS is intended to provide a detailed analysis of select remedial alternatives.
17 The results of the detailed analysis provide the basis for identifying preferred alternatives.
18 The detailed analysis for alternatives consists of the following components:

- 19
- 20 • Further definition of each alternative, if appropriate, with respect to the
21 volumes or areas of contaminated environmental media to be addressed,
22 the technologies to be used, and any performance requirements associated
23 with those technologies. Remedial investigations and treatability studies, if
24 conducted, will also be used to further define applicable alternatives.
- 25
- 26 • An assessment and summary of each alternative against evaluation criteria
27 specified in EPA's *Guidance for Conducting Remedial Investigations and*
28 *Feasibility Studies under CERCLA* (EPA 1988b).
- 29
- 30 • A comparative analysis of the alternatives that will facilitate the selection of
31 a remedial action.
- 32
- 33

34 9.4.2 Final Feasibility Study

35

36 To complete the remediation process for an aggregate area, a final or summary
37 FS will be prepared. This study will address those sites not previously evaluated and will
38 summarize the results of preceding evaluations. The overall study and evaluation process
39 for an aggregate area will consist of a number of FFSs, field investigations, and interim
40 RODs. All of this study information will be summarized in one final FS to provide the
41 data necessary for the final ROD. The summary FS will likely be conducted on an

1 aggregate area basis; however, future considerations may indicate that a larger scope is
2 appropriate.

3 4 5 9.5 TREATABILITY STUDIES

6
7 A range of technologies which are likely to be considered for remediation of sites
8 within the Semi-Works Aggregate Area were discussed in Section 7.3. The range of
9 technologies included:

- 10
11 • Engineered multimedia cover
12
13 • In situ grouting
14
15 • Excavation and soil treatment
16
17 • In situ vitrification
18
19 • Excavation, treatment, and disposal of transuranic radionuclides
20
21 • In situ soil vapor extraction of volatile organic compounds.
22

23 Treatability testing will be required to conduct a detailed analysis for most of the
24 technologies. Relevant EPA guidance will be relied upon to conduct these future
25 treatability studies. A summary of treatability testing needs outlined in Section 7.3 is as
26 follows:

- 27
28 • In situ grouting—Field pilot tests would be required to assess the required
29 injection well spacing and the optimum grout injection methods; bench-
30 scale and pilot-scale tests would be required to demonstrate the
31 effectiveness for stabilizing the contaminants.
32
33 • Excavation and above-ground soil treatment—The performance of some
34 treatment alternatives would depend on the soil type and contaminant
35 properties at each individual waste management unit. Pilot-scale tests
36 might be needed to demonstrate innovative dust control methods at units
37 where fugitive dust must be stringently controlled. Bench-scale and pilot-
38 scale tests would be needed for treatment technologies whose performance
39 depends on site-specific soil properties; stabilization, soil washing, and
40 vitrification. Treatability tests are probably not required to support some
41 treatment technologies that are not strongly affected by soil properties:

1 physical separation, and thermal desorption of volatile and semivolatile
2 organic compounds.

- 3
- 4 • In situ treatment vitrification—This technology is currently under
5 development, and serious operational problems have been encountered
6 during field demonstrations. Extensive bench-scale and pilot-scale testing
7 would be required before this technology could be applied to any full scale
8 disposal site.
 - 9
 - 10 • Excavation, treatment, and disposal of transuranic radionuclides—There
11 are no licensed disposal sites for transuranic wastes, so implementation of
12 this technology will depend on future siting and licensing of a facility.
13 Treatment methods for stabilization and/or treatment of transuranic
14 radionuclides are in only the development stages, so extensive bench-scale
15 and pilot-scale testing would be required to support this technology.
 - 16
 - 17 • In situ soil vapor extraction of volatile organic compounds—Pilot-scale tests
18 would be required to determine the spacing of the extraction wells, the
19 vented air flowrate, and the design of the vacuum pumps. Analysis of the
20 vented air during the pilot-scale test would be required to assess emission
21 control methods.
 - 22

23 As treatability testing of the various alternatives progresses, other parameters are
24 likely to be identified which require further development.
25
26
27

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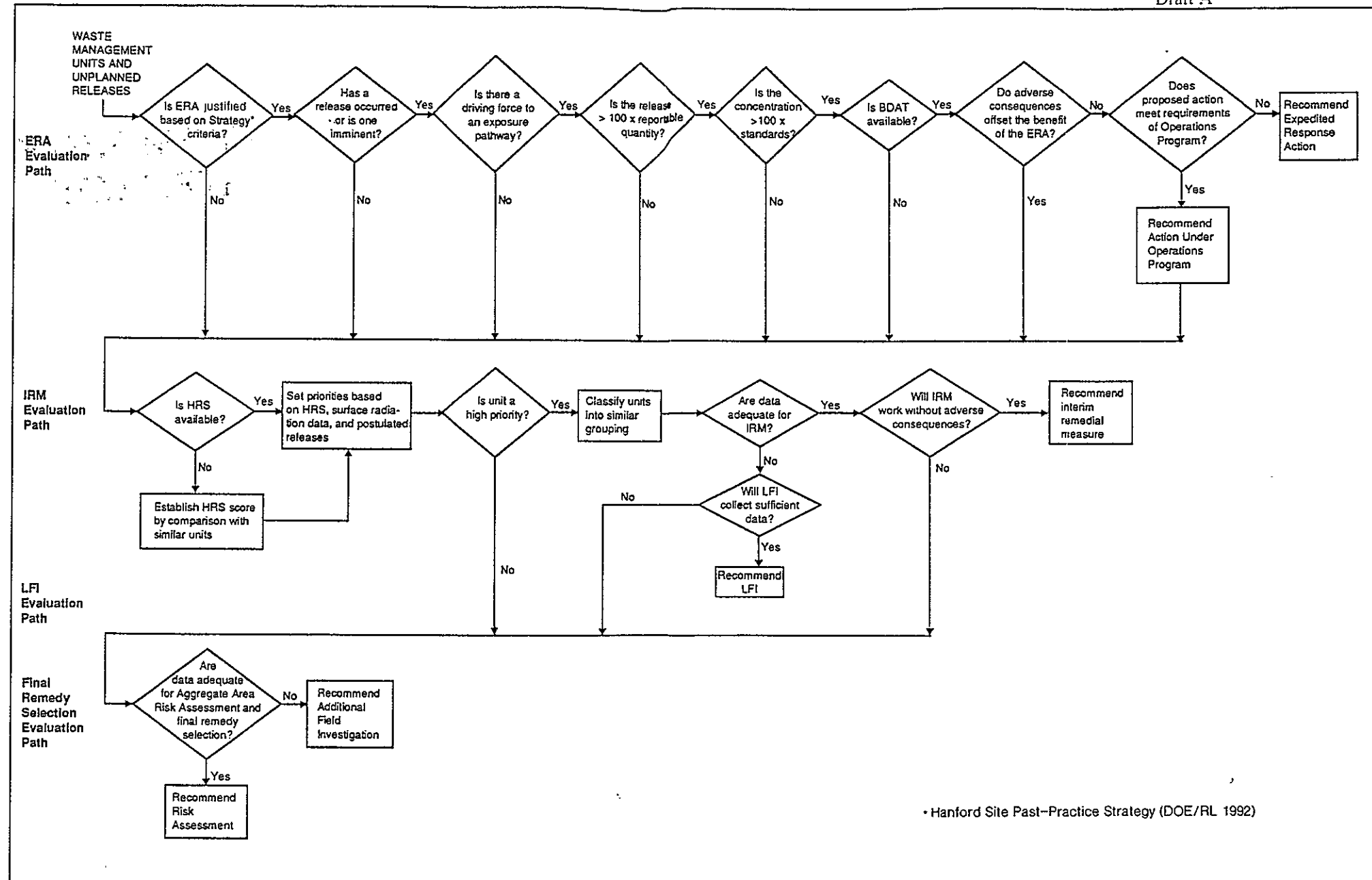


Figure 9-1. 200 Aggregate Area Management Study Data Evaluation Process.

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Table 9-1. Summary of the Results of Remediation Process Path Assessment. (Sheet 1 of 3)

Waste Management Unit	ERA	IRM	LFI	RA	RI	OPS	Remarks
Plants, Buildings, and Storage Areas							
201-C Process Building					X		Structures have been stabilized under Hanford Surplus Facilities Program.
291-C Ventilation System					X		
Tanks and Vaults							
241-CX-70 Storage Tank					X		Tanks to be decontaminated and decommissioned under Hanford Surplus Facilities Program and closed under RCRA Program. Evaluations for post-closure care or remediation to be performed under Final Remedy Selection Path.
241-CX-71 Storage Tank					X		
241-CX-72 Storage Tank					X		
Cribs and Drains							
216-C-1 Crib		X	X				All cribs included under one analogous group. 216-C-1 Crib to be investigated as analogue site, with supplemental LFIs at 216-C-7 and 216-C-10 Cribs.
216-C-3 Crib		X	X				
216-C-4 Crib		X	X				
216-C-5 Crib		X	X				
216-C-6 Crib		X	X				
216-C-7 Crib		X	X				
216-C-10 Crib		X	X				
Reverse Wells							
216-C-2 Reverse Well					X		Unit has been decontaminated and decommissioned under Hanford Surplus Facilities Program.

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Table 9-1. Summary of the Results of Remediation Process Path Assessment. (Sheet 2 of 3)

Waste Management Unit	ERA	IRM	LFI	RA	RI	OPS	Remarks
Ponds, Ditches, and Trenches							
216-C-9 Pond					X		Unit has been decontaminated and decommissioned under Hanford Surplus Facilities Program.
200 East Powerhouse Ditch					X		To be removed from the Semi-Works operable unit and included as a waste management unit under B Plant AAMS
Septic Tanks and Associated Drain Fields							
2607-E-5 Septic Tank and Drain Field					X		
2607-E-7A Septic Tank and Drain Field					X		
Transfer Facilities, Diversion Boxes, and Pipelines							
Semi-Works Valve Pit					X		Unit has been decontaminated and decommissioned under Hanford Surplus Facilities Program.
Critical Mass Laboratory Valve Pit					X		To be decommissioned under Hanford Surplus Facilities Program, then evaluated under Final Remedy Selection Path.
241-C-154 Diversion Box					X		Unit has been decontaminated and decommissioned under Hanford Surplus Facilities Program.
Burial Sites							
218-C-9 Burial Ground					X		
Unplanned Releases							
UN-200-E-36				X			
UN-200-E-37					X		

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Table 9-1. Summary of the Results of Remediation Process Path Assessment. (Sheet 3 of 3)

Waste Management Unit	ERA	IRM	LFI	RA	RI	OPS	Remarks
UN-200-E-98					X		
UN-200-E-141					X		

ERA - Expedited Response Action

IRM - Interim Remedial Measure

LFI - Limited Field Investigation

RA - Risk Assessment

RI - Remedial Investigation

OPS - Operational Programs

Table 9-2. Semi-Works Aggregate Area Data Evaluation
Decision Matrix. (Sheet 1 of 2)

Waste Management Unit	ERA Evaluation Pathway								IRM Evaluation Pathway			LFI Path	Final Remedy
	Hanford Site Past-Practice Strategy Criteria?	Release?	Path-way?	Quantity?	Concentration?	Treatment Available?	Adverse Consequences?	Operational Programs?	High Priority?	Data Adequate?	Adverse Consequences?	Collect Data?	Data Adequate?
Plants, Buildings, and Storage Areas													
201-C Process Building	N	—	—	—	—	—	—	—	N	—	—	—	N
291-C Ventilation System	N	—	—	—	—	—	—	—	N	—	—	—	N
Tanks and Vaults													
241-CX-70 Storage Tank	N	—	—	—	—	—	—	—	N	—	—	—	N
241-CX-71 Storage Tank	N	—	—	—	—	—	—	—	N	—	—	—	N
241-CX-72 Storage Tank	N	—	—	—	—	—	—	—	N	—	—	—	N
Cribs and Drains													
216-C-1 Crib	Y	Y	N	—	—	—	—	—	Y	N	—	Y	—
216-C-3 Crib	Y	Y	N	—	—	—	—	—	N*	N	—	Y	—
216-C-4 Crib	Y	Y	N	—	—	—	—	—	N*	N	—	Y	—
216-C-5 Crib	Y	Y	N	—	—	—	—	—	N*	N	—	Y	—
216-C-6 Crib	Y	Y	N	—	—	—	—	—	N*	N	—	Y	—
216-C-7 Crib	Y	Y	N	—	—	—	—	—	N*	N	—	Y	—
216-C-10 Crib	Y	Y	N	—	—	—	—	—	Y	N	—	Y	—
Reverse Wells													
216-C-2 Reverse Well	Y	N	—	—	—	—	—	—	N	—	—	—	N
Ponds, Ditches, and Trenches													
216-C-9 Pond	Y	Y	N	—	—	—	—	—	N	—	—	—	N
200 East Powerhouse Ditch	N	—	—	—	—	—	—	—	N	—	—	—	N

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**Table 9-2. Semi-Works Aggregate Area Data Evaluation
Decision Matrix. (Sheet 2 of 2)**

	ERA Evaluation Pathway								IRM Evaluation Pathway			LFI Path	Final Remedy
Waste Management Unit	Hanford Site Past-Practice Strategy Criteria?	Release?	Path-way?	Quan-tity?	Concen-tration?	Treat-ment Available?	Adverse Conse-quences?	Opera-tional Pro-grams?	High Priority?	Data Ade-quate?	Adverse Conse-quences?	Collect Data?	Data Ade-quate?
Septic Tanks and Associated Drain Fields													
2607-E-5 Septic Tank and Drain Field	N	—	—	—	—	—	—	—	N	—	—	—	N
2607-E-7A Septic Tank and Drain Field	N	—	—	—	—	—	—	—	N	—	—	—	N
Transfer Facilities, Diversion Boxes, and Pipelines													
Semi-Works Valve Pit	N	—	—	—	—	—	—	—	N	—	—	—	N
Critical Mass Laboratory Valve Pit	Y	N	—	—	—	—	—	—	N	—	—	—	N
241-C-154 Diversion Box	N	—	—	—	—	—	—	—	N	—	—	—	N
Burial Sites													
218-C-9 Burial Ground	N	—	—	—	—	—	—	—	N	—	—	—	N
Unplanned Releases													
UN-200-E-36	N	—	—	—	—	—	—	—	N	—	—	—	Y
UN-200-E-37	N	—	—	—	—	—	—	—	N	—	—	—	N
UN-200-E-98	Y	Y	N	—	—	—	—	—	N	—	—	—	N
UN-200-E-141	Y	Y	N	—	—	—	—	—	N	—	—	—	N

N = No

Y = Yes

* Evaluated as high priority site because of proximity and/or similarity to other high priority sites.

ERA = Expedited Response Action

IRM = Interim Remedial Measure

LFI = Limited Field Investigation

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APPENDIX A
SUPPLEMENTAL DATA

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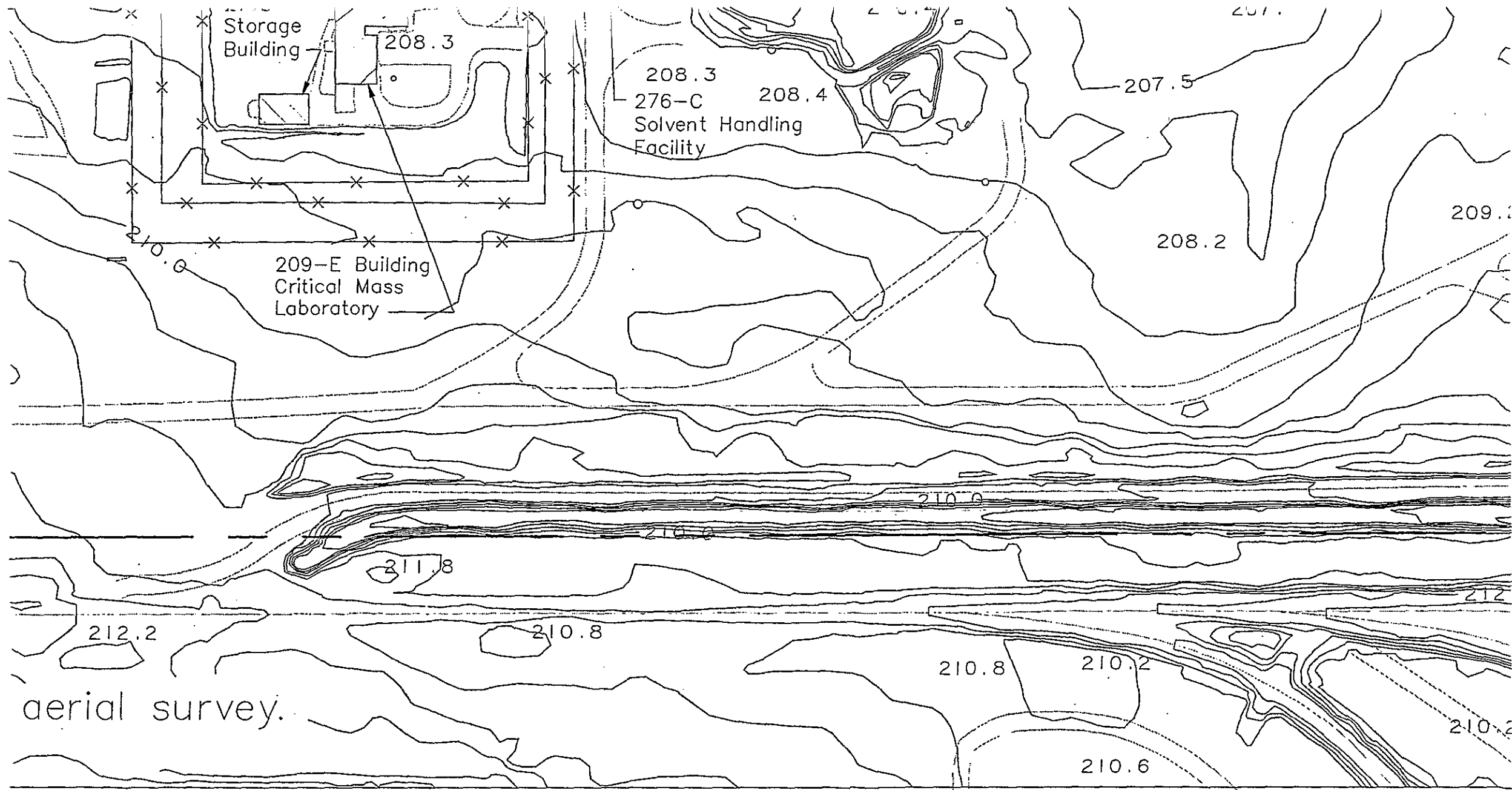


Plate 1. Topographic Map of Semi-Works Aggregate Area

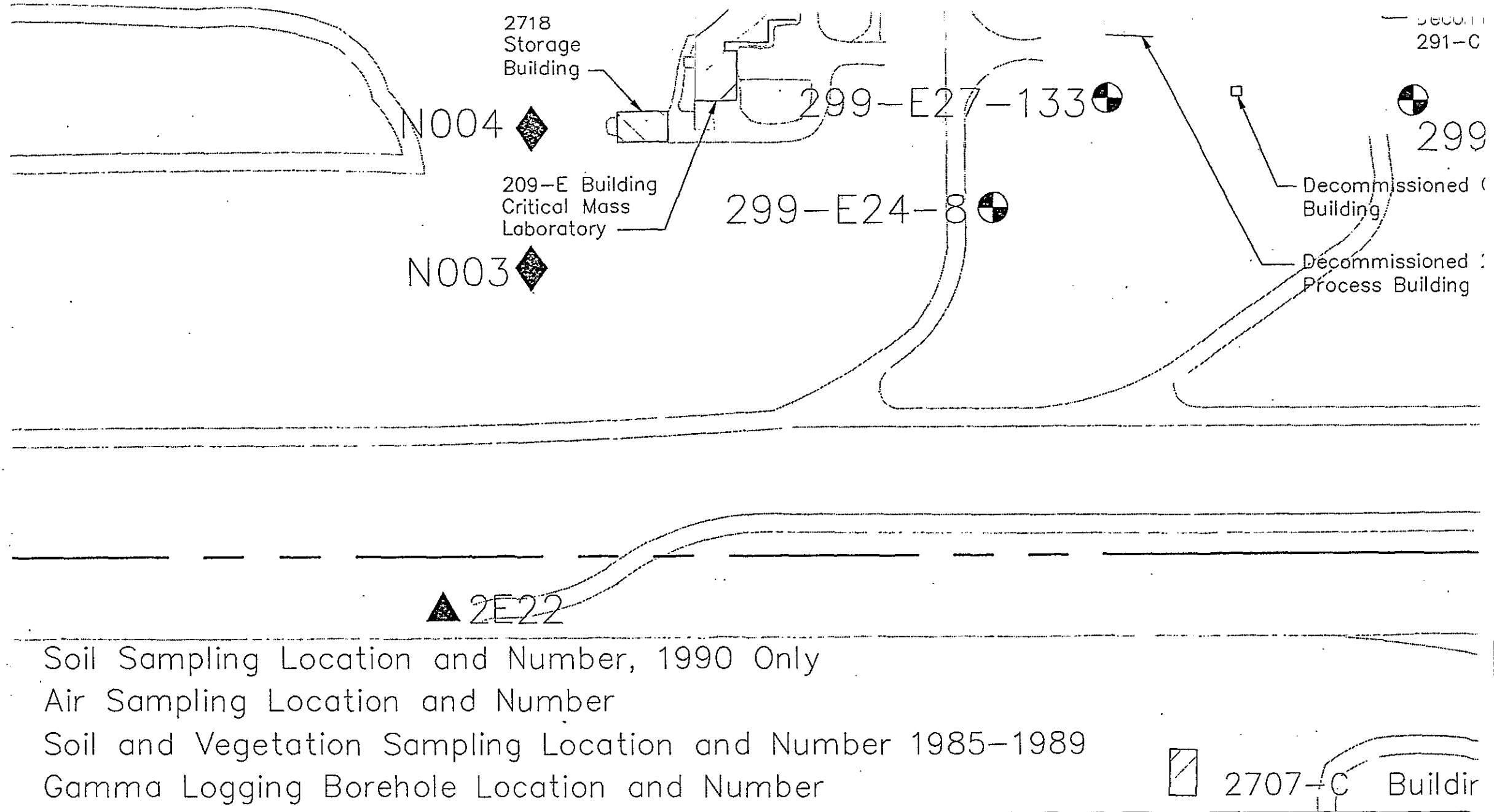


Plate 2. Semi-Works Aggregate Area Surface Media and A

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A.1.0 GEOPHYSICAL DATA

A.1.1 INTRODUCTION

Geophysical well logging has been conducted in monitoring wells located within the 200 East and West Areas since 1954 and in the Semi-Works Aggregate Area since at least as early as 1959. Such logging can be used to map lithologic boundaries (Additon et al. 1978; Last et al. 1989; Brodeur and Koizumi 1989), soil moisture content and to evaluate the location and extent of radionuclides in the subsurface due to waste disposal activities (Fecht et al. 1977; Additon et al. 1978). The geophysical borehole logging techniques which have been used include density, neutron, temperature and gross gamma radiation logging. The most successful of these for mapping lithologic boundaries and monitoring radionuclides in the subsurface has been the gross gamma logging. The other techniques have been less successful either because they are not suitable for use in cased holes or they do not measure radiation.

Previous studies based on the gross gamma logs collected from wells monitoring various waste management units in the 200 East and West Areas were conducted in 1964, 1969, 1977, 1978, and 1986. The tank farms located in the 200 East and West Areas were not considered in these reports. Additon et al. (1978) report that the 1964 study (Raymond and McGhan 1964) discusses the disposition of radionuclides beneath most of the waste management units active between 1945 and 1963. The 1969 study (Tillson and McGhan 1969) is reported by Additon et al. (1978) to be a discussion of the waste management units where significant changes in the gamma logs were observed after 1963. The report by Fecht et al. (1977) is a qualitative study of the distribution, redistribution and decay of radionuclides beneath approximately 100 waste management units in the 200 East and West Areas. Fecht et al. (1977) included a summary of the waste disposal history of each facility evaluated and based their conclusions on approximately 300 selected gross gamma logs collected between 1954 and 1976. Plots of the logs used were provided with the report. Additon et al. (1978) provide a complete summary of the logging systems used and a discussion of the limitations of using gross gamma logs to evaluate the distribution and composition of radionuclides in the subsurface. The methodologies employed to qualitatively evaluate the gross gamma logs collected from wells monitoring the waste disposal facilities in the 200 East and West Areas were also summarized. Plots of the gross gamma logs collected from 154 monitoring wells outside the tank farms in the 200 East Area was included in the report by Additon et al. (1978). Chamness (1986) reviewed gross gamma logs available from selected wells in the 200 area and qualitatively summarized any changes in the logs between 1976 and 1986.

Four inactive waste management units in the Semi-Works Aggregate Area which are monitored by wells in which gross gamma logs have been collected were evaluated in

1 this study. These waste management units have been qualitatively evaluated in terms of
2 the location and extent of radionuclides in the subsurface, any evidence of vertical or
3 lateral migration, and the potential for radionuclides reaching the ground water. The
4 results of the evaluations for these waste management units are summarized in Section
5 A.1.4.

8 A.1.2 GROSS GAMMA LOGGING

10 Borehole gross gamma radiation measurements are used to determine the level
11 of gamma activity with depth in the vicinity of the well bore. These measurements do
12 not differentiate between the mechanisms through which gamma radiation is produced or
13 the energy of the gamma radiation photons detected. The response of the gamma
14 radiation detector to different energy levels is generally unknown, except perhaps for the
15 lowest energy photon detectable (Arthur 1990). Gross gamma logs cannot be used to
16 determine the isotopic composition of the subsurface since this is determined through the
17 analysis of the energy spectra of the gamma radiation detected. The capability to
18 measure the spectra of gamma radiation detected in the subsurface and assay the types
19 and amounts of isotopes present is currently being developed, but has not yet reached
20 the stage of practical application.

22 The gamma logs available for the Semi-works Aggregate Area were collected
23 with scintillation probes by Pacific Northwest Laboratories (PNL) or by the Tank Farm
24 Surveillance Analysis and Support group (TFSA&S). Scintillation probes detect the flash
25 of light produced by the interaction between a gamma photon and a crystal of thallium-
26 activated sodium iodide (NaI(Tl)) with a photomultiplier tube. The resulting pulse of
27 electricity is amplified, routed through a signal generator and sent through the logging
28 cable to the surface. The pulses are separated from the electrical signal with a
29 discriminator, amplified, counted by a rate meter and output to a pen plotter which is
30 driven at a rate determined by the logging speed (Fecht et al. 1977; Additon et al. 1978;
31 Brodeur and Koizumi 1989; Arthur 1990).

33 The accuracy and precision of gamma activity measurements in the subsurface is
34 determined by details of the logging system instrumentation, the field data acquisition
35 methodology, the surrounding media and the radionuclides present. The relationship
36 between the gamma activity detected by a scintillation probe and the actual activity, the
37 distance gamma radiation may travel through geologic materials before being completely
38 attenuated and the vertical resolution of changes in activity by the logging systems used is
39 discussed below.

41 The time required for the logging system to process a detected gamma photon, or
42 "dead time," is an important limitation in the measurement gamma activity (Brodeur and

1 Koizumi 1989; Arthur 1990). During this short span of time, no other photons will be
2 processed by the instrument. The "dead time" computed for the PNL system currently in
3 use is 17.8 microseconds (Arthur 1990). Based on this value, the maximum count rate
4 this logging system is capable of is about 56,000 ct/sec. If the activity is above that level,
5 the system will become "paralyzed" and read 0 ct/sec until it resets itself. The maximum
6 count rate of the TFSA&S system currently in use is about 100,000 ct/sec with Probe No.
7 4 (Strong 1980). This suggests that the "dead time" of their logging system is about 10
8 microseconds. There is no evidence that the TFSA&S system will become paralyzed if
9 this activity level is exceeded.

10
11 The actual gamma activity on an interval may be computed by multiplying the
12 "dead time" corrected activity by a factor consistent with the amount of attenuation due
13 to well construction. The amount of attenuation the gamma radiation experiences in
14 penetrating well casing is significant. A single string of casing reduces the count rate
15 measured by the scintillation probe by about 25%, groundwater in an uncased hole
16 reduces the observed count rate by 11%, and groundwater in a cased hole reduces the
17 observed count rate by about 33% (Brodeur and Koizumi 1989; Arthur 1990).

18
19 The relationship between the gamma activity observed with a scintillation probe
20 and the actual activity is linear over much of the system's range. However, above some
21 threshold activity level, the relationship between the observed and actual activity becomes
22 non-linear. At this point the tool is said to be saturated. The gross gamma logging
23 system currently in use by PNL becomes saturated around 14,500 ct/sec (Brodeur and
24 Koizumi 1989; Arthur 1990), and that currently in use by TFSA&S with Probe No. 4
25 becomes saturated around 70,000 ct/sec (Strong 1980).

26
27 Where the relationship between the observed and actual gamma activity is linear,
28 and complete details of well construction are available, the activity may be converted to
29 standard units related to decay rates or to concentrations of specific radionuclides
30 (thorium or uranium for example). Such conversions allow the direct comparison of data
31 collected by different logging systems and quantitative analyses of the concentrations of
32 gamma emitters with depth. To achieve this, it is necessary to calibrate the scintillation
33 probes used with a model bore hole containing intervals with known activities (Strong
34 1980; Brodeur and Koizumi 1989; Arthur 1990). The rigorous procedures and facilities
35 necessary for calibrating scintillation probes have not yet been completed.

36
37 A scintillation probe is calibrated by periodically adjusting the components of the
38 system to meet established specifications and by logging a test well with intervals of
39 known activity under standard conditions. The probe's calibration is then verified in the
40 field before and after each logging run using portable equipment and procedures which
41 are correlated with those of the calibration procedure. Standard conditions are
42 established by constructing the test bore hole in a known geologic environment with

1 background radiation levels similar to those found in the area where the probe is used.
2 The test well should be constructed in a similar fashion to the wells to be logged by the
3 probe (Brodeur and Koizumi 1989).
4

5 The average distance through which gamma radiation penetrates geologic and
6 well construction materials and is still detected by the scintillation probe is known as the
7 radius of investigation. This distance is determined by the density of the media
8 surrounding the bore hole, the well construction materials, and the energy and intensity
9 of the gamma radiation. The average radius of investigation for gross gamma radiation
10 measurements in an open hole is about 0.3 m (1 ft) from the wall of the bore hole in
11 sedimentary rocks (Schlumberger 1972). The radius of investigation is larger on intervals
12 where there are high concentrations of radionuclides since higher intensities of gamma
13 radiation will penetrate a greater thickness of a given material. The radius of
14 investigation is decreased by well casing, grout, and groundwater since they increase the
15 effective density of sediments. Another factor in determining the radius of investigation
16 is the tool response to low energy (frequency) gamma photons. The scintillation probe
17 currently used by PNL has a low energy cutoff of between 46.5 and 59.5 keV (Arthur
18 1990). Gamma radiation with energies below this value will not be detected by that
19 probe. The low energy cutoff for the probes used by TFSA&S is unknown.
20

21 The vertical resolution and apparent location of a change in the gamma activity
22 measured by a scintillation probe depends upon details of how the probe signal is
23 processed by the rate meter and the logging speed. The rate meter used in PNL's
24 logging system differs from that used by TFSA&S. The rate meter used by PNL smooths
25 its output using an electronic circuit (an RC circuit). The amount of smoothing is
26 determined by the time constant of the circuit used. This removes statistical variations in
27 the signal detected by the scintillation probe and improves the reproducibility and
28 sensitivity of the data. However, a "lag" is introduced between the depth at which a
29 change in the gamma activity is first encountered by the scintillation probe and the depth
30 at which it is plotted. The size of this "depth lag" is the distance traveled before half of
31 the amplitude of the change in activity is recorded. One time constant is required to
32 reach 63% of the amplitude of any change in activity. So, the "depth lag" is
33 approximately the product of the logging speed and the time constant used
34 (Schlumberger 1972). Before 1989, the logging speed used by PNL was 4.6 m/min (15
35 ft/min) (0.25 ft/sec) and the time constant used was 3 seconds. This results in a depth lag
36 of 0.2 m (0.75 ft). The thinnest interval of elevated activity which can be resolved is also
37 0.2 m (0.75 ft) on these older profiles. In 1989, the logging speed was reduced to 1.5 m
38 (5 ft/min) (1 in./sec) and the time constant to 1 second. The expected vertical resolution
39 and "depth lag" of these logs is 1 inch (2.54 centimeters).
40
41

A.1.3 TECHNICAL APPROACH

Scintillation probe profiles collected periodically from monitoring wells within the Semi-works Aggregate Area have been used to qualitatively assess the location and extent of radionuclides in the subsurface, any evidence of vertical or lateral migration, and the potential for radionuclides from waste disposal activities reaching the groundwater. The approach used here is similar to that of Fecht et al. (1977). Scintillation probe profiles collected from wells monitoring a facility or group of facilities were compiled and analyzed in an attempt to gain an understanding of the subsurface distribution of gamma emitters from waste disposal activities. Each analysis is accompanied by a summary of the types and sources of wastes handled, the service dates and the volume of wastes disposed of or stored at a given facility. The conclusions reached in these evaluations should not be considered the final word since they are based on a limited data set which can only be used for qualitative purposes.

Geological methods of analysis incorporating cross sections and mapping of subsurface attributes such as the thickness of zones of elevated gamma radiation and relevant lithologic horizons were used extensively. The advantages of this approach are the clearer representation of potential subsurface conditions around the waste disposal facilities, and identification of data deficiencies. It is assumed that the activity detected on the gamma logs represent diffuse, continuous sources of radiation.

Fecht et al. (1977) attempted to normalize the scintillation probe profiles used in their evaluations to a level consistent with the profiles collected in 1976. This normalization scheme involved scaling the profiles from each vintage using an average peak to background ratio and bulk shifting the corrected curves to correspond to the 1976 profiles. Since there are distinct differences between the response characteristics of each logging system and their modifications (in the saturation levels, low energy cutoff, etc), there are doubts to the validity of such an exercise. The logs used in the evaluations presented here have not been normalized.

There has been no attempt to quantitatively compare the activity levels detected by different vintages of scintillation probes in the evaluations presented here. If gross changes in the profiles are evident, they have been noted in a qualitative sense.

The criteria used to identify radionuclide decay are the significant, consistent decline of activity levels and the "narrowing" of the features representing elevated radiation on the logs over time. However, such changes may also be indicative of lateral migration of radionuclides away from a particular well. Identification of lateral migration is generally uncertain. The most reliable criteria for identifying lateral migration of radionuclides is the notable increase of activity on an interval in a well that is down gradient (of a stratigraphic or hydrologic boundary) from other wells with elevated

1 activity on a similar interval. It is very important to consider the spacial and temporal
2 context of the scintillation probe data in determining if lateral migration has occurred,
3 even on a qualitative level.

4
5 Although the activity measured by the scintillation probes cannot be quantified to
6 known standards, the activity in the subsurface may be reliably located. The location of
7 features in the scintillation probe profiles such as the top and bottom of intervals of
8 elevated gamma radiation are generally found at the same depth on successive logs.
9 Depth discrepancies of up to 1.52 m (5 ft) have been noted between logs. Differences in
10 the responses of the PNL logging systems may account for some of this discrepancy.

11
12 All of the available well data were reviewed for each area evaluated, and selected
13 logs were used to construct cross sections representative of subsurface conditions. These
14 cross sections were correlated with stratigraphic information from nearby wells, regional
15 cross sections and regional mapping. Boundaries of zones of elevated gamma radiation
16 were also marked. The evaluation of the scintillation probe profiles referenced these
17 graphical representations to describe the location and extent of any zones of elevated
18 gamma radiation, and the behavior of this zone over time, particularly in regards to
19 vertical or lateral migration. Any evidence of gamma emitters reaching the groundwater
20 was also noted.

21
22 To represent the logs used in the cross sections in a clear, yet compact format
23 and to facilitate comparisons between different vintages of data, it was necessary to
24 digitize the original logs and to redisplay them on a semi-logarithmic scale. Depth in feet
25 from the top of casing was represented on the linear scale, and activity in ct/sec on the
26 logarithmic scale. The logs used in these evaluations which were collected before 1976,
27 and some of the 1976 vintage logs had been previously digitized by PNL, who provided
28 text files of the information. The inset plan on the figure illustrates the spatial
29 relationship of the wells used in the cross section.

30
31 In the Semi-Works Aggregate Area, the upper 80 m (262 ft) is the Hanford
32 formation which consists of interbedded coarse sands, gravelly sands, and sandy gravel.
33 This unit has a fairly low and uniform gamma response. Underlying the Hanford
34 formation are the sands and gravel of the Ringold Formation. In the Semi-Works
35 Aggregate Area the Ringold Formation is approximately 20 to 30 m (65 to 98 ft) thick
36 and rests on top of the Elephant Mountain member of the Columbia River Basalt
37 Group. The gamma response of the Ringold Formation in this area is also fairly low and
38 uniform.

39
40 In all logs that penetrate to groundwater there is a striking increase in the
41 gamma response typically from 10 to 20 ct/sec to around 100 to 300 ct/sec. This increase

is present in logs from 1959 and later to varying degrees and probably represents groundwater contamination.

A.1.4 EVALUATION OF DATA IDENTIFIED FOR WASTE MANAGEMENT UNITS

Based on availability of both gross gamma-ray logs and geologic logs for a particular waste management unit, an analysis of the potential nature and extent of radionuclide contamination was performed. Sections A.1.4.1 through A.1.4.4 discuss data identified for the following waste management units:

- 216-C-1 Crib
- 216-C-5 Crib
- 216-C-10 Crib
- 216-C-9 Pond/218-C-9 Burial Ground.

A.1.4.1 216-C-1 Crib

A.1.4.1.1 Waste Description. This section briefly summarizes information presented in Tables 2-1 and 2-2, and Sections 2.3.3.1 and 4.1 concerning this 216-C-1 Crib.

Source - High salt waste, cold run waste, and process condensate from the 201-C Process Building

Service Dates - 1953 to 1957

Fluid Volume Received in Liters - 23,400,000

Quantity of Radionuclides Disposed of in 216-C-1 Crib in Curies

Waste Management Unit	Total Pu in gm	²³⁸ U	¹³⁷ Cs	¹⁰⁶ Ru	⁹⁰ Sr	⁶⁰ Co	³ H	²³⁹ Pu	²⁴⁰ Pu
216-C-1 Crib	8.0	0.0988	0.0455 0.0496	1.89E-08	85.5 93.8	0.002	70.0	0.4579	0.1230

A.1.4.1.2 Scintillation Probe Profile Evaluation. As shown on Figure A-1, soil boring 299-E27-133 which is located 5 m (16 ft) east of the crib, shows an elevated

gamma response to the total depth of 15.4 m (50.5 ft). Peak counts occur 2 to 3 m (6.5 to 9.8 ft) below ground surface in the range of 2,000 to 3,000 ct/sec. This suggests that there is subsurface radionuclide contamination in the vicinity of the 216-C-1 Crib.

A.1.4.2 216-C-5 Crib

A.1.4.2.1 Waste Description. This section briefly summarizes information presented in Tables 2-1 and 2-2, and Sections 2.3.3.4 and 4.1 concerning the 216-C-5 Crib.

Source - High salt waste and cold run waste from the 201-C Process Building

Service Dates - 1955

Fluid Volume Received in Liters - 37,900

Quantity of Radionuclides Disposed of in 216-C-5 Crib in Curies

Waste Management Unit	Total Pu in gm	²³⁸ U	¹³⁷ Cs	¹⁰⁶ Ru	⁹⁰ Sr	⁶⁰ Co	³ H	²³⁹ Pu	²⁴⁰ Pu
216-C-5	1.0	0.0182	0.0444 0.484	1.38E-10	4.2 4.610	0.0018			

A.1.4.2.2 Scintillation Probe Profile Evaluation. As shown on the logs for Well 299-E-24-8 on Figure A-1 there is an elevated gamma response between 0 and 2 m (0 to 6.5 ft) below ground surface. Peak values are approximately 30,000 ct/sect. This response is not present prior to the 1968 log and gains in intensity between 1968 and 1976. Fecht et al. (1977) attribute this to a waste transfer line located 3.2 m (10.5 ft) from the well and not to the 216-C-5 Crib located 20 m (65 ft) to the north. It cannot be determined at this time whether there is contamination migration beneath the 216-C-5 Crib.

A.1.4.3 216-C-10 Crib

A.1.4.3.1 Waste Description. This section briefly summarizes information presented in Tables 2-1 and 2-2, and Sections 2.3.3.7 and 4.1 concerning the 216-C-10 Crib.

Source - Acidic process condensate from the 201-C Process Building

Service Dates - 1964 to 1969

Fluid Volume Received in Liters - 897,000

Quantity of Radionuclides Disposed of in 216-C-10 Crib in Curies

Waste Management Unit	Total Pu in gm	²³⁸ U	¹³⁷ Cs	¹⁰⁶ Ru	⁹⁰ Sr	⁶⁰ Co	³ H	²³⁹ Pu	²⁴⁰ Pu
216-C-10 Crib	0.15	0.00001	0.0855 0.0932	8.95E-08	3.45 37.8	0.0113			

A.1.4.3.2 Scintillation Probe Profile Evaluation. Well 299-E27-5, located 3 m (10 ft) north of the crib, shows no elevated gamma response other than in the groundwater.

A.1.4.4 216-C-9 Pond/218-C-9 Burial Ground

A.1.4.4.1 Waste Description. This section briefly summarizes information presented in Tables 2-1 and 2-2, and Sections 2.3.5.1, 2.3.9.1, and 4.1 concerning the 216-C-9 Pond/ 218-C-9 Burial Ground.

Source - The 216-C-9 Pond received process cooling water from the 201-C Process Building and the Hot Semi-Works facilities, and wastewater from the 209-E Building. The 218-C-9 Burial Ground received 2.265 m³ (80 ft³) of rubble (rags, paper, cardboard, plastic, equipment and other dry waste) from decommissioning of the 201-C Process Building

Service Dates - 1953 to 1985/1985

Fluid Volume Received in Liters - 1,030,000,000/NA

Quantity of Radionuclides Disposed of in 216-C-9 Pond in Curies

Waste Management Unit	Total Pu in gm	²³⁸ U	¹³⁷ Cs	¹⁰⁶ Ru	⁹⁰ Sr	⁶⁰ Co	³ H	²³⁹ Pu	²⁴⁰ Pu
216-C-9 Pond	0.338		0.703	8.66E-08	2.43				

A.1.4.4.2 Scintillation Probe Profile Evaluation. Well-299-E27-1, as shown on Figure A-1, shows a natural gamma response. It is, however, located approximately 50 m (164 ft) north of the Pond area and may not be representative of conditions closer to the actual site.

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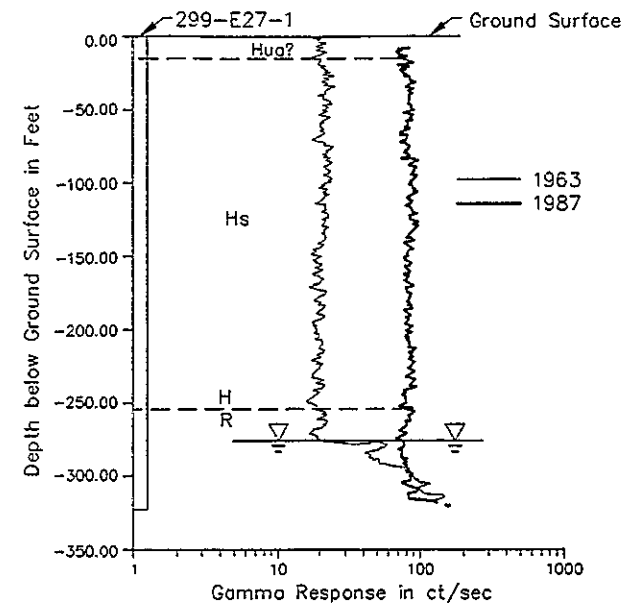
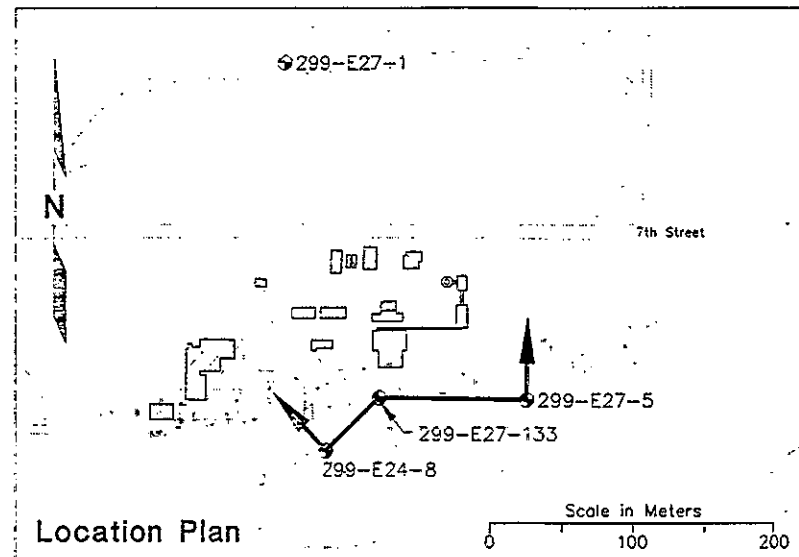
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- 2 *1968, 200 Area Waste Disposal Site Monitoring Wells*, BNWL-CC-2255, Battelle
- 3 *Pacific Northwest Laboratories, Richland, Washington.*
- 4

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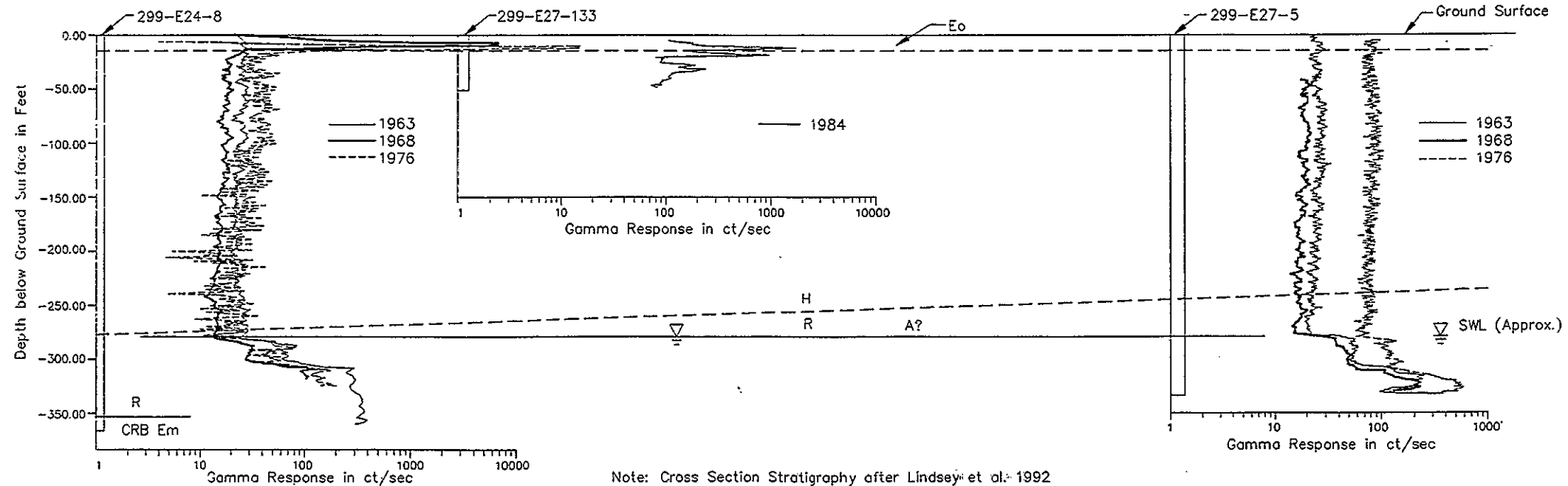


Horizontal Scale in Feet
0 50 100
0 100 200

Vertical Scale in Feet
Vertical Exaggeration x 0.5

Horizontal Scale in Meters
0 10 20 30
0 20 40 60

Vertical Scale in Meters
Vertical Exaggeration x 0.5



Note: Cross Section Stratigraphy after Lindsey et al. 1992

Figure A-1. Semi-Works Aggregate Area
Borehole Gamma Response Data

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SAMPLE DATA TABLES

9 3 1 2 3 9 0 4 5 4

Table A-1. Air Sampling Results. (Sheet 1 of 4)

Radionuclide in pCi/m ³		1985		1986		1987		1988		1989		Average Result
		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	
Sample Location: N001												
Strontium-90	max	not sampled		not sampled		not sampled		8.0E-04	2.9E-04	not sampled		6.0E-04
	min							4.0E-04	1.8E-04			
	avg							6.0E-04	4.1E-04			
Cesium-137	max							5.6E-04	5.6E-04			-9.0E-06
	min							<-5.8E-04	1.1E-03			
	avg							-9.0E-06	1.2E-03			
Plutonium-239	max							6.6E-06	5.8E-06			6.5E-06
	min							6.5E-06	5.8E-06			
	avg							6.5E-06	1.0E-07			
Uranium (total)	max							2.8E-05	3.7E-05			1.2E-05
	min							<-4.1E-06	2.3E-05			
	avg							1.2E-05	3.5E-05			

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Table A-1. Air Sampling Results. (Sheet 2 of 4)

Radionuclide in pCi/m ³		1985		1986		1987		1988		1989		Average Result
		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	
Sample Location: N002												
Strontium-90	max	not sampled		not sampled		not sampled		4.3E-04	1.7E-04	not sampled		3.7E-04
	min							3.1E-04	1.9E-04			
	avg							3.7E-04	1.2E-04			
Cesium-137	max							<-1.1E-04	9.2E-04			-9.0E-06
	min							<9.3E-05	7.3E-04			
	avg							-9.0E-06	2.8E-04			
Plutonium-239	max							3.2E-05	1.1E-05			2.4E-05
	min							1.7E-05	9.6E-06			
	avg							2.4E-05	1.5E-05			
Uranium (total)	max							5.3E-06	2.4E-05			-4.7E-07
	min							<-6.2E-06	3.6E-05			
	avg							-4.7E-07	1.7E-05			

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Table A-1. Air Sampling Results. (Sheet 3 of 4)

Radionuclide in pCi/m ³		1985		1986		1987		1988		1989		Average Result
		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	
Sample Location: N003												
Strontium-90	max	not sampled		not sampled		not sampled		5.6E-03	9.7E-04	3.9E-04	1.6E-04	
	min							2.6E-04	1.4E-04	9.4E-05	8.1E-05	
	avg							1.1E-03	1.7E-03	2.6E-04	1.3E-04	
Cesium-137	max							1.5E-03	8.5E-04	4.3E-04	4.7E-04	
	min							<2.1E-04	4.1E-04	-9.8E-06	5.0E-04	
	avg							5.3E-04	6.5E-04	1.6E-04	4.3E-04	
Plutonium-239	max							9.3E-06	4.7E-06	3.9E-06	3.3E-06	
	min							<-5.2E-08	1.1E-06	9.0E-07	5.1E-06	
	avg							4.0E-06	4.3E-06	2.7E-06	3.4E-06	
Uranium (total)	max							7.5E-06	2.2E-05	4.5E-05	2.9E-05	
	min							<-3.9E-06	1.9E-05	3.2E-05	1.6E-05	
	avg							-2.9E-07	8.7E-06	2.7E-05	2.0E-05	

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Table A-1. Air Sampling Results. (Sheet 4 of 4)

Radionuclide in pCi/m ³		1985		1986		1987		1988		1989		Average Result
		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	
Sample Location: N004												
Strontium-90	max	not sampled		not sampled		not sampled		6.9E-04	2.6E-04	not sampled		4.2E-04
	min							1.9E-04	1.1E-04			
	avg							4.2E-04	3.0E-04			
Cesium-137	max							1.3E-03	1.0E-03			7.9E-04
	min							<3.2E-04	4.7E-04			
	avg							7.9E-04	6.6E-04			
Plutonium-239	max							8.9E-06	4.7E-06			7.9E-06
	min							6.3E-06	4.2E-06			
	avg							7.9E-06	1.9E-06			
Uranium (total)	max							1.1E-04	6.1E-05			5.6E-05
	min							<3.2E-06	2.0E-05			
	avg							5.6E-05	6.8E-05			

Notes:

— — indicates radionuclide not analyzed, or results not reported.

Shaded entry indicates a positive detection, result greater than measurement error.

Negative values indicate concentration at or near background levels for radioactivity (Ref: 1988 and 1989 data).

Sample data not available for 1985 through 1987.

Data Sources:

Rockwell Hanford Operations Environmental Surveillance Annual Monitoring Reports -- 200/600 Areas (1985 and 1986).

Westinghouse Hanford Operations Environmental Surveillance Annual Monitoring Reports -- 200/600 Areas (1987 through 1990).

Table A-2. Results of Grid Soil Sampling. (Sheet 1 of 2)

Radionuclide in pCi/g	1985		1986		1987		1988		1989		Average Result
	Result	Error	Result	Error	Result	Error	Result	Error	Result (1)	Error	
Sample 2E16											
Cerium-141	---	---	---	---	6.70E-03	3.60E-02	---	---	---	---	6.7E-03
Cerium-144	---	---	---	---	1.00E-02	1.20E-01	-1.30E-01	1.30E-01	---	---	-6.0E-02
Cobalt-58	3.10E-02	2.40E-02	---	---	-1.70E-02	2.00E-02	6.50E-03	1.70E-02	---	---	6.8E-03
Cobalt-60	---	---	---	---	9.90E-03	1.60E-02	1.50E-02	2.20E-02	---	---	1.2E-02
Cesium-134	---	---	7.00E-02	3.00E-02	1.90E-02	2.20E-02	-4.50E-03	1.80E-02	---	---	2.8E-02
Cesium-137	3.05E+00	2.23E-01	4.26E+00	4.60E-01	4.30E+00	4.40E-01	3.00E+00	3.10E-01	---	---	3.7E+00
Europium-152	1.55E-01	1.26E-01	---	---	8.00E-02	8.20E-02	8.60E-02	7.80E-02	---	---	1.1E-01
Europium-154	---	---	---	---	3.30E-02	5.20E-02	-4.30E-02	5.80E-02	---	---	-5.0E-03
Europium-155	---	---	---	---	-3.00E-02	5.50E-02	-1.90E-03	7.50E-02	---	---	-1.6E-02
Iodine-129	---	---	---	---	---	---	a	---	---	---	---
Potassium-40	---	---	---	---	---	---	---	---	---	---	---
Manganese-54	---	---	4.00E-02	3.00E-02	2.60E-02	1.50E-02	-1.20E-03	1.90E-02	---	---	2.2E-02
Niobium-95	---	---	---	---	---	---	---	---	---	---	---
Lead-212	---	---	---	---	---	---	---	---	---	---	---
Lead-214	---	---	---	---	---	---	6.60E-01	9.20E-02	---	---	6.6E-01
Plutonium-238	1.30E-03	5.00E-04	---	---	1.20E-03	3.90E-04	1.00E-03	4.00E-04	---	---	1.2E-03
Plutonium-239	1.06E-01	1.10E-02	8.20E-02	1.40E-02	1.20E-01	1.20E-02	6.60E-02	7.70E-03	---	---	9.4E-02
Ruthenium-106	---	---	---	---	2.30E-01	1.30E-01	-1.00E-02	1.70E-01	---	---	1.1E-01
Strontium-90	1.70E+00	3.08E-01	2.70E+00	5.00E-01	1.70E+00	4.10E-01	1.20E+00	2.30E-01	---	---	1.8E+00
Technetium-99	---	---	---	---	---	---	---	---	---	---	---
Uranium	2.93E-01	9.90E-02	6.50E-01	2.20E-01	3.10E-01	9.00E-02	2.60E-01	8.50E-02	---	---	3.8E-01
Zinc-65	---	---	---	---	-2.20E-02	4.50E-02	-6.40E-02	4.80E-02	---	---	-4.0E-02
Zirconium-95	---	---	9.00E-02	7.00E-02	2.40E-02	3.60E-02	1.80E-02	3.50E-02	---	---	1.4E-02

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Table A-2. Results of Grid Soil Sampling. (Sheet 2 of 2)

Radionuclide in pCi/g	1985		1986 (1)		1987		1988		1989		Average Result
	Result	Error	Result	Error	Result	Error	Result	Error	Result (1)	Error	
Sample 2E22											
Cerium-141	---	---	---	---	Site Not Sampled		---	---			---
Cerium-144	---	---	---	---			-1.10E-02	9.20E-02			-1.1E-02
Cobalt-58	---	---	---	---			4.40E-03	1.70E-02			4.4E-03
Cobalt-60	---	---	---	---			8.60E-03	1.30E-02			8.6E-03
Cesium-134	---	---	3.00E-02	2.00E-02			-1.40E-02	1.70E-02			8.0E-03
Cesium-137	2.29E+00	1.89E-01	3.05E+00	3.20E-01			1.50E+00	1.60E-01			2.3E+00
Europium-152	1.25E-01	1.16E-01	1.20E-01	8.00E-02			7.30E-02	7.30E-02			1.1E-01
Europium-154	---	---	---	---			2.30E-02	5.00E-02			2.3E-02
Europium-155	---	---	---	---			6.90E-02	5.30E-02			6.9E-02
Iodine-129	---	---	---	---			a				---
Potassium-40	---	---	---	---			---	---			---
Manganese-54	---	---	---	---			1.30E-02	1.80E-02			1.3E-02
Niobium-95	---	---	---	---			---	---			---
Lead-212	---	---	---	---			---	---			---
Lead-214	---	---	---	---			7.80E-01	9.90E-02			7.8E-01
Plutonium-238	9.00E-04	6.00E-04	2.00E-03	1.00E-03			6.40E-04	3.00E-04			1.2E-03
Plutonium-239	1.49E-01	1.60E-02	2.22E-01	2.70E-02			9.60E-02	1.10E-02			1.6E-01
Ruthenium-106	---	---	---	---			-8.80E-02	1.40E-01			-8.8E-02
Strontium-90	8.41E-01	1.58E-01	5.60E-01	1.10E-01			1.70E-01	3.40E-02			5.2E-01
Technetium-99	---	---	---	---			---	---			---
Uranium	1.66E-01	6.80E-02	6.00E-01	2.00E-01			3.70E-01	1.20E-01			3.9E-01
Zinc-65	---	---	---	---			-4.30E-02	4.40E-02			-4.3E-02
Zirconium-95	---	---	5.00E-02	4.00E-02			-1.60E-03	3.00E-02			2.5E-02

Notes:

--- indicates radionuclide not analyzed, or results not reported. No data reported for 1990.

Shaded entries indicate a positive detection, result greater than error.

(a) designation indicates radionuclide concentration is less than detectable (ref: 1985 data only).

Negative values indicates concentration at or near background levels for radioactivity.

Data Sources:

Rockwell Hanford Operations Environmental Surveillance Annual Monitoring Reports -- 200/600 Areas (1985 and 1986).

Westinghouse Hanford Operations Environmental Surveillance Annual Monitoring Reports -- 200/600 Areas (1987 through 1990).

AT-2b

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Table A-3. Grid Site Vegetation Results for the Semi-Works Aggregate Area (1985-1989). (Sheet 1 of 2)

Radionuclide in pCi/g	1985		1986 (1)		1987		1988		1989		Average Result
	Result	Error	Result	Error	Result	Error	Result	Error	Result (1)	Error	
Sample 2E16											
Cerium-141	---	---	---	---	---	---	-2.80E-02	8.30E-02	not sampled		-2.8E-02
Cerium-144	---	---	---	---	---	---	---	---			---
Cobalt-58	---	---	---	---	---	---	---	---			---
Cobalt-60	2.11E-02	1.33E-02	---	---	---	---	-8.60E-03	1.70E-02			6.3E-03
Cesium-134	---	---	3.99E-01	6.75E-02	1.00E-01	2.70E-02	2.30E-02	1.60E-02			1.7E-01
Cesium-137	1.07E-01	1.63E-02	8.05E-01	1.07E-01	2.80E-01	4.20E-02	2.80E-01	3.90E-02			3.7E-01
Europium-152	9.96E-02	4.22E-02	---	---	2.50E-02	7.80E-02	8.00E-03	7.40E-02			4.5E-02
Europium-154	---	---	---	---	1.60E-02	5.90E-02	-2.70E-03	5.10E-02			6.7E-03
Europium-155	---	---	---	---	-6.90E-03	5.00E-02	-1.80E-02	4.50E-02			1.2E-02
Iodine-129	---	---	---	---	---	---	a				---
Potassium-40	---	---	---	---	---	---	---	---			---
Manganese-54	---	---	---	---	---	---	---	---			---
Niobium-95	---	---	---	---	---	---	-3.80E-02	6.30E-02			-3.8E-02
Lead-212	---	---	---	---	---	---	---	---			---
Lead-214	---	---	---	---	---	---	---	---			---
Plutonium-238	---	---	---	---	---	---	a				---
Plutonium-239	---	---	---	---	---	---	a				---
Ruthenium-103	---	---	3.33E-01	1.21E-01	---	---	---	---			3.3E-01
Ruthenium-106	---	---	4.84E-01	2.75E-01	---	---	---	---			4.8E-01
Strontium-90	---	---	---	---	---	---	a				---
Technetium-99	---	---	---	---	---	---	a				---
Uranium	---	---	---	---	---	---	---	---			---
Zinc-65	---	---	---	---	---	---	---	---			---
Zirconium-95	---	---	---	---	---	---	2.30E-02	5.70E-02			2.3E-02

AT-3a

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Table A-3. Grid Site Vegetation Results for the Semi-Works Aggregate Area (1985-1989). (Sheet 2 of 2)

Radionuclide in pCi/g	1985		1986 (1)		1987		1988		1989		Average Result
	Result	Error	Result	Error	Result	Error	Result	Error	Result (1)	Error	
Sample 2E22											
Cerium-141	---	---	---	---	not sampled		-4.20E-02	7.60E-02	not sampled		-4.2E-02
Cerium-144	---	---	---	---			---	---			---
Cobalt-58	---	---	---	---			---	---			---
Cobalt-60	---	---	3.86E-02	3.33E-02			-3.10E-03	1.80E-02			2.3E-02
Cesium-134	---	---	2.53E-01	6.67E-02			---	---			2.5E-01
Cesium-137	1.07E-01	1.11E-02	2.66E-01	1.11E-01			1.50E-01	2.80E-02			3.4E-01
Europium-152	2.52E-02	2.21E-02	---	---			0.00E+00	7.20E-02			2.5E-02
Europium-154	2.15E-02	2.01E-02	---	---			3.20E-02	5.90E-02			---
Europium-155	---	---	---	---			8.90E-03	4.40E-02			8.9E-03
Iodine-129	---	---	---	---			a	---			---
Potassium-40	---	---	---	---			---	---			---
Manganese-54	---	---	---	---			---	---			---
Niobium-95	---	---	---	---			-1.80E-02	5.50E-02			-1.8E-02
Lead-212	---	---	---	---			---	---			---
Lead-214	---	---	---	---			---	---			---
Plutonium-238	---	---	---	---			a	---			---
Plutonium-239	---	---	---	---			a	---			---
Ruthenium-103	2.31E-02	8.00E-03	4.54E-01	1.36E-01			---	---			2.4E-01
Ruthenium-106	1.94E-01	5.18E-02	1.38E+00	4.41E-01			a	---			7.8E-01
Strontium-90	---	---	---	---			---	---			---
Technetium-99	---	---	---	---			---	---			---
Uranium	---	---	---	---			---	---			---
Zinc-65	---	---	---	---			---	---			---
Zirconium-95	1.10E-02	1.08E-02	---	---			1.90E-02	5.50E-02			1.5E-02

Notes:

— indicates radionuclide not analyzed, or results not reported. No data reported for 1990.

(a) designation indicates radionuclide concentration is less than detectable (ref: 1985 data only).

Shaded entries indicate a positive detection, result greater than error.

Negative values indicate concentration at or near background levels for radioactivity (refer to 1988 and 1989 data).

Data Sources:

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Table A-4. Summary of Gamma Radiation Logs Reviewed.

Waste Management Unit	Well Number	Number of Times Logged	Dates
216-C-1 Crib	299-E27-133	1	3/84
216-C-5 Crib	299-E24-8	4	5/59-5/76
216-C-10 Crib	299-E27-5	3	5/63-5/76
216-C-9 Pond	299-E27-1	3	5/59-7/87

APPENDIX B
HEALTH AND SAFETY PLAN

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ACRONYMS AND ABBREVIATIONS

AAMS	aggregate area management study
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
EII	Environmental Investigations Instructions
HEHF	Hanford Environmental Health Foundation
HSP	health and safety plan
HWOP	Hazardous Waste Operations Permit
JSA	Job Safety Analysis
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
RCRA	Resource Conservation Recovery Act
RWP	Radiation Work Permit
SCBA	self-contained breathing apparatus
Westinghouse Hanford	Westinghouse Hanford Company
WISHA	Washington Industrial Safety and Health Act

1.0 GENERAL CONSIDERATIONS AND REQUIREMENTS

1.1 INTRODUCTION

The purpose of this Health and Safety Plan (HSP) is to outline standard health and safety procedures for Westinghouse Hanford Company (Westinghouse Hanford) employees and contractors engaged in investigation activities in the Semi-Works Aggregate Area Management Study (AAMS). These activities will include surface investigation, drilling and sampling boreholes, and environmental sampling in areas of known chemical and radiological contamination. Appropriate site-specific safety documents (e.g., Hazardous Waste Operations Permit [HWOP] or Job Safety Analysis [JSA]) will be written for each task or group of tasks. A more complete discussion of Westinghouse Hanford environmental safety procedures is presented in the Westinghouse Hanford manual *Health and Safety for Hazardous Waste Field Operations*, WHC-CM-4-3 vol. 4 (WHC 1992).

All employees of Westinghouse Hanford or any other contractors who are participating in on-site activities in the Semi-Works AAMS shall read the site-specific safety document and attend a pre-job safety or tailgate meeting to review and discuss the task.

1.2 DESIGNATED SAFETY PERSONNEL

The field team leader and site safety officer are responsible for site safety and health. Specific individuals will be assigned on a task-by-task basis by project management, and their names will be properly recorded before the task is initiated.

All activities on-site must be cleared through the field team leader. The field team leader has responsibility for the following:

- Allocating and administering resources to successfully comply with all technical and health and safety requirements
- Verifying that all permits, supporting documentation, and clearances are in place (e.g., electrical outage requests, welding permits, excavation permits, HWOP or JSA, sampling plan, radiation work permits [RWP], and onsite/offsite radiation shipping records)

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- Providing technical advice during routine operations and emergencies
- Informing the appropriate site management and safety personnel of the activities to be performed each day
- Coordinating resolution of any conflicts that may arise between RWPs and the implementation of the HWOP or JSA with health physics
- Handling emergency response situations as may be required
- Conducting pre-job and daily tailgate safety meetings
- Interacting with adjacent building occupants and/or inquisitive public.

The site safety officer is responsible for implementing the HWOP at the site. The site safety officer shall do the following:

- Monitor chemical, physical, and (in conjunction with the health physics technician) radiation hazards to assess the degree of hazard present; monitoring shall specifically include organic vapor detection, radiation screening, and confined space evaluation where appropriate
- Determine protection levels, clothing, and equipment needed to ensure the safety of personnel in conjunction with the health physics department
- Monitor the performance of all personnel to ensure that the required safety procedures are followed
- Halt operations immediately, if necessary, due to safety or health concerns
- Conduct safety briefings as necessary
- Assist the field team leader in conducting safety briefings as necessary.

The health physics technician is responsible for ensuring that all radiological monitoring and protection procedures are being followed as specified in the Radiation Protection Manual and in the appropriate RWP. Westinghouse Hanford Industrial Safety and Fire Protection personnel will provide safety overview during drilling operations consistent with Westinghouse Hanford policy and, as requested, will provide technical advice. Also, downwind sampling for hazardous materials and radiological contaminants and other analyses may be requested from appropriate contractor personnel as required.

1 The ultimate responsibility and authority for employee's health and safety lies with
2 the employee and the employee's colleagues. Each employee is responsible for exercising
3 the utmost care and good judgment in protecting personal and fellow employee health
4 and safety. Should any employee observe a potentially unsafe condition or situation, it is
5 the responsibility of that employee to immediately bring the observed condition to the
6 attention of the appropriate health and safety personnel, as designated previously. In the
7 event of an immediately dangerous or life-threatening situation, the employee
8 automatically has temporary "stop work" authority and the responsibility to immediately
9 notify the field team leader or site safety officer. When work is temporarily halted
10 because of a safety or health concern, personnel will exit the exclusion zone and meet at
11 a predetermined place in the support zone. The field team leader, site safety officer, and
12 health physics technician will determine the next course of action.

13 14 15 **1.3 MEDICAL SURVEILLANCE**

16
17 All field team members engaged in operable unit activities at sites governed by an
18 HWOP must have baseline physical examinations and be participants in Westinghouse
19 Hanford (or an equivalent) hazardous waste worker medical surveillance program.

20
21 Medical examinations will be designed to identify any pre-existing conditions that
22 may place an employee at high risk, and will verify that each worker is physically able to
23 perform the work required by this plan without undue risk to personal health. The
24 physician shall determine the existence of conditions that may reduce the effectiveness or
25 prevent the employee's use of respiratory protection. The physician shall also determine
26 the presence of conditions that may pose undue risk to the employee while performing
27 the physical tasks of this work plan using level B personal protection equipment. This
28 would include any condition that increases the employee's susceptibility to heat stress.

29
30 The examining physician's report will not include any nonoccupational diagnoses
31 unless directly applicable to the employee's fitness for the work required.

32 33 34 **1.4 TRAINING**

35
36 Before engaging in any on-site activities, each team member is required to have
37 received 40 hours of health and safety training related to hazardous waste site operations
38 and at least 8 hours of refresher training each year thereafter as specified in 29 Code of
39 Federal Regulations (CFR) 1910.120. In addition, each inexperienced employee (never
40 having performed site characterization) will be directly supervised by a
41 trained/experienced person for a minimum of 24 hours of field experience.

1 The field team leader and the site safety officer shall receive an additional 8 hours
2 of training (in addition to the refresher training previously discussed).
3
4

5 **1.5 TRAINING FOR VISITORS**

6

7 For the purposes of this plan, a visitor is defined as any person visiting the
8 Hanford Site, who is not a Westinghouse Hanford employee or a Westinghouse Hanford
9 contractor directly involved in the Resource Conservation and Recovery Act
10 (RCRA)/Comprehensive Environmental Response, Compensation and Liability Act of
11 1980 (CERCLA) facility investigation activities, including but not limited to those
12 engaged in surveillance, inspection, or observation activities.
13

14 Visitors who must, for whatever reason, enter a controlled (either contamination
15 reduction or exclusion) zone, shall be subject to all of the applicable training, respirator
16 fit testing, and medical surveillance requirements discussed in Westinghouse Hanford
17 Environmental Investigations Instructions (EII) 1.1 and Appendix B to EII 1.1 (WHC
18 1991).
19

20 All visitors shall be informed of potential hazards and emergency procedures by
21 their escorts and shall conform to EII 1.1 (WHC 1991).
22
23

24 **1.6 RADIATION DOSIMETRY**

25

26 All personnel engaged in on-site activities shall be assigned dosimeters according
27 to the requirements of the RWP applicable to that activity. All visitors shall be assigned
28 basic dosimeters, as a minimum, that will be exchanged annually.
29
30

31 **1.7 REQUIREMENTS FOR THE USE OF RESPIRATORY PROTECTION**

32

33 All employees of Westinghouse Hanford and subcontractors who may be required
34 to use air-purifying or air-supplied respirators must be included in the medical
35 surveillance program and be approved for the use of respiratory protection by the
36 Hanford Environmental Health Foundation (HEHF) or other licensed physician. Each
37 team member must be trained in the selection, limitations, and proper use and
38 maintenance of respiratory protection (existing respiratory protection training may be
39 applicable towards the 40-hour training requirement).
40

41 Before using a negative pressure respirator, each employee must have been fit-
42 tested (within the previous year) for the specific make, model, and size according to

Westinghouse Hanford fit-testing procedures. Beards (including a few days' growth), large sideburns, or moustaches that may interfere with a proper respirator seal are not permitted.

Subcontractors must provide evidence to Westinghouse Hanford that personnel are participants in a medical surveillance and respiratory protection program that complies with 29 CFR 1910.120 and 29 CFR 1910.134, respectively.

2.0 GENERAL PROCEDURES

The following personal hygiene and work practice guidelines are intended to prevent injuries and adverse health effects. A hazardous waste site poses a multitude of health and safety concerns because of the variety and number of hazardous substances present. These guidelines represent the minimum standard procedures for reducing potential risks associated with this project and are to be followed by all job-site employees at all times.

2.1 GENERAL WORK SAFETY PRACTICES

2.1.1 Work Practices

The following work practices must be observed:

- Eating, drinking, smoking, taking certain medications, chewing gum, and similar actions are prohibited within the exclusion zone. All sanitation facilities shall be located outside the exclusion zone; decontamination is required before using such facilities.
- Personnel shall avoid direct contact with contaminated materials unless necessary for sample collecting or required observation. Remote handling of such things as casings and auger flights will be practiced whenever practical.
- While operating in the controlled zone, personnel shall use the buddy system where appropriate, or be in visual contact with someone outside of the controlled zone.

- The buddy system will be used where appropriate for manual lifting.
- Requirements of Westinghouse Hanford radiation protection and RWP manuals shall be followed for all work involving radioactive materials or conducted within a radiologically controlled area.
- On-site work operations shall only be carried out during daylight hours, unless the entire control zone is adequately illuminated with artificial lighting. A new tour (shift) will operate the drilling rig after completion of each shift.
- Do not handle soil, waste samples, or any other potentially contaminated items unless wearing the protective equipment specified in the HWOP or JSA.
- Whenever possible, stand upwind of excavations, boreholes, well casings, drilling spoils, and the like, as indicated by an on-site windsock.
- Stand clear of trenches during excavation. Always approach an excavation from upwind.
- Be alert to potentially changing exposure conditions as evidenced by such indications as perceptible odors, unusual appearance of excavated soils, or oily sheen on water.
- Do not enter any test pit or trench deeper than 1.2 m (4 ft) unless in accordance with procedures specified in the HWOP.
- Do not under any circumstances enter or ride in or on any backhoe bucket, materials hoist, or any other similar device not specifically designed for carrying passengers.
- All drilling team members must make a conscientious effort to remain aware of their own and others' positions in regards to rotating equipment, cat heads, or U-joints. Drilling operations members must be extremely careful when assembling, lifting, and carrying flights or pipe to avoid pinch-point injuries and collisions.
- Tools and equipment will be kept off the ground whenever possible to avoid tripping hazards and the spread of contamination.

- Personnel not involved in operation of the drill rig or monitoring activities shall remain a safe distance from the rig as indicated by the field team leader.
- Follow all provisions of each site-specific hazardous work permit as addressed in the HWOP, including cutting and welding, confined space entry, and excavation.
- Catalytic converters on the underside of vehicles are sufficiently hot to ignite dry prairie grass. Team members should not drive over dry grass that is higher than the ground clearance of the vehicle and should be aware of the potential fire hazard posed by catalytic converters at all times. Never allow a running or hot vehicle to sit in a stationary location over dry grass or other combustible materials.
- Follow all provisions of each site-specific RWP.
- Team members will attempt to minimize truck tire disturbance of all stabilized sites.

2.1.2 Personal Protective Equipment

- Personal protective equipment will be selected specifically for the hazards identified in the HWOP. The site safety officer in conjunction with Westinghouse Hanford Health Physics and Industrial Hygiene and Safety is responsible for choosing the appropriate type and level of protection required for different activities at the job site.
- Levels of protection shall be appropriate to the hazard to avoid either excessive exposure or additional hazards imposed by excessive levels of protection. The HWOP will contain provisions for adjusting the level of protection as necessary. These personal protective equipment specifications must be followed at all times, as directed by the field team leader, health physics technician, and site safety officer.
- Each employee must have a hard hat, safety glasses, and substantial protective footwear available to wear as specified in the HWOP or JSA.
- The exclusion zone around drilling or other noisy operations will be posted "Hearing Protection Required" and team members will have had noise control training.

- Personnel should maintain a high level of awareness of the limitations in mobility, dexterity, and visual impairment inherent in the use of level B and level C personal protective equipment.
- Personnel should be alert to the symptoms of fatigue, heat stress, and cold stress and their effects on the normal caution and judgment of personnel.
- Rescue equipment as required by Occupational Safety and Health Administration (OSHA), Washington Industrial Safety and Health Act (WISHA), or standards for working over water will be available and used.

2.1.3 Personal Decontamination

- The HWOP will describe in detail methods of personnel decontamination, including the use of contamination control corridors and step-off pads when appropriate.
- Thoroughly wash hands and face before eating or putting anything in the mouth to avoid hand-to-mouth contamination.
- At the end of each work day or each job, disposable clothing shall be removed and placed in (chemical contamination) drums, plastic-lined boxes or other containers as appropriate. Clothing that can be cleaned may be sent to the Hanford Site laundry.
- Individuals are expected to thoroughly shower before leaving the work site or Hanford Site if directed to do so by the health physics technician, site safety officer, or field team leader.

2.1.4 Emergency Preparation

- A multipurpose dry chemical fire extinguisher, a fire shovel, a complete field first-aid kit, and a portable pressurized spray wash unit shall be available at every site where there is potential for personnel contamination.
- Prearranged hand signals or other means of emergency communication will be established when respiratory protection equipment is to be worn, because this equipment seriously impairs speech.

- The Hanford Fire Department shall be initially notified before the start of the site investigation project. This notification shall include the location and nature of the various types of field work activities as described in the work plan. A site location map shall be included in this notification.

2.2 CONFINED SPACE/TEST PIT ENTRY PROCEDURES

The following procedures apply to the entry of any confined space, which for the purpose of this document shall be defined as any space having limited egress (access to an exit) and the potential for the presence or accumulation of a toxic or explosive atmosphere. This includes manholes, certain trenches (particularly those through waste disposal areas), and all test pits greater than 1 m (4 ft) deep. If confined spaces are to be entered as part of the work operations, a hazardous work permit (filled out for confined space entry) must be obtained from Industrial Safety and Fire Protection.

The identified remedial investigation activities on the Semi-Works AAMS should not require confined space entry. Nevertheless, the hazards associated with confined spaces are of such severity that all employees should be familiar with the safe work discussed in the following paragraphs.

No employee shall enter any test pit or trench deeper than 1 m (4 ft) unless the sides are shored or laid back to a stable slope as specified in OSHA 29 CFR 1926.652 or equivalent state occupational health and safety regulations.

When an employee is required to enter a pit or trench 1 m (4 ft) deep or more, an adequate means of access and egress, such as a slope of at least 2:1 to the bottom of the pit or a secure ladder or steps shall be provided.

Before entering any confined space, including any test pit, the atmosphere will be tested for flammable gases, oxygen deficiency, and organic vapors. If other specific contamination, such as radioactive materials or other gases and vapors may be present, additional testing for those substances shall be conducted. Depending on the situation, the space may require ventilation and retesting before entry.

An employee entering a confined or partially confined space must be equipped with an appropriate level of respiratory protection in keeping with the monitoring procedures discussed previously and the action levels for airborne contaminants (see "Warnings and Action Levels" in HWOP).

No employee shall enter any test pit requiring the use of level B protection, unless a backup person also equipped with a pressure-demand self-contained breathing

apparatus (SCBA) is present. No backup person shall attempt any emergency rescue unless a second backup person equipped with an SCBA is present, or the appropriate emergency response authorities have been notified and additional help is on the way.

3.0 SITE BACKGROUND

Specific details on the Semi-Works AAMS background and known and suspected contamination are described in Chapters 2.0 through 10.0 of the plan. The Semi-Works Aggregate Area is situated within the 200 West Area of the U.S. Department of Energy's (DOE) Hanford Site, in the south-central portion of the state of Washington. The 200 West Area is located in Benton County in the central portion of the Hanford Site. It is adjacent to the 200 East Area, located roughly 5 km (3 mi) to the west.

The Semi-Works Aggregate Area at the Hanford Site was used by the U.S. Government as a chemical separations area in the process to produce plutonium for nuclear weapons. These operations resulted in the release of chemical and radioactive wastes into the soil, air, and water of the area. Each waste site in the aggregate area is described separately in this document. Close relationships between waste units, such as overflow from one to another, are also discussed.

4.0 SCOPE OF WORK AND POTENTIAL HAZARDS

While the information presented in Chapters 2.0 through 10.0 of the plan are believed to be representative of the constituents and quantities of wastes at the time of discharge, the present chemical nature, location, extent, and ultimate fate of these wastes in and around the liquid disposal facilities are largely unknown. The emphasis of the investigation in the Semi-Works AAMS will be to characterize the nature and extent of contamination in the vadose (unsaturated subsurface soil) zone.

4.1 WORK TASKS

Work tasks are described in Chapter 5.0 of the plan.

4.2 POTENTIAL HAZARDS

On-site tasks will involve noninvasive surface sampling procedures and invasive soil sampling either directly in or immediately adjacent to areas known or suspected to contain potentially hazardous chemical substances, toxic metals, and radioactive materials.

Surface radiological contamination and fugitive dust will be the potential hazards of primary concern during noninvasive mapping and sampling activities.

Existing data indicate that hazardous substances may be encountered during invasive sampling; these include radionuclides, heavy metals, and corrosives. In addition, volatile organics may also be associated with certain facilities such as the solvent storage buildings or underground storage tanks.

Potential hazards include the following:

- External radiation (gamma and to a lesser extent, beta) from radioactive materials in the soil;
- Internal radiation resulting from radionuclides present in contaminated soil entering the body by ingestion or through open cuts and scratches;
- Internal radiation resulting from inhalation of particulate (dust) contaminated with radioactive materials;
- Inhalation of toxic vapors or gases such as volatile organics or ammonia;
- Inhalation or ingestion of particulate (dust) contaminated with inorganic or organic chemicals, and toxic metals;
- Dermal exposure to soil or groundwater contaminated with radionuclides;
- Dermal exposure to soil or groundwater contaminated with inorganic or organic chemicals, and toxic metals;
- Physical hazards such as noise, heat stress, and cold stress;
- Slips, trips, falls, bumps, cuts, pinch points, falling objects, other overhead hazards, crushing injuries, and other hazards typical of a construction-related job site;
- Unknown or unexpected underground utilities; and

- Biological hazards; snakes, spiders, etc.

4.3 ASSESSMENT AND MITIGATION OF POTENTIAL HAZARDS

The likelihood of significant exposure (100 mrem/h or greater) to external radiation is remote and can be readily monitored and controlled by limiting exposure time, increasing distance, and employing shielding as required.

Internal radiation by inhalation or inadvertent ingestion of contaminated dust is a realistic concern and must be continuously evaluated by the health physics technician. Appropriate respiratory protection, protective clothing, and decontamination procedures will be implemented as necessary to reduce potential inhalation, ingestion, and dermal exposure to acceptable levels.

Dermal exposure to toxic chemical substances is not expected to pose a significant problem for the identified tasks given the use of the designated protective clothing. The appropriate level of personal protective clothing and respiratory protection will vary from work site to work site.

5.0 ENVIRONMENTAL AND PERSONAL MONITORING

The site safety officer or authorized delegate shall be present at all times during work activities which require an HWOP, and shall be in charge of all environmental/personal monitoring equipment. Industrial Hygiene and Safety shall review all activities involving or potentially involving radiological exposure or contamination control and shall prescribe the appropriate level of technical support and/or monitoring requirements. Other equipment deemed necessary by the site safety officer or Industrial Hygiene and Safety shall be obtained at their direction; work will not be initiated or continued until such equipment is in place. These instruments are to be used only by persons who are trained in their use and who understand their limitations. No work shall be performed unless instrumentation is available and in proper working order.

Air sampling may be required downwind of the referenced waste sites to monitor particulates and vapors before job startup. Siting of such sampling devices will be determined by Health Physics, the site safety officer, and HEHF, if appropriate. Any time personnel exposure monitoring, other than radiological, is required to determine exposure levels, it must be done by HEHF. Discrete sampling of ambient air within the

1 work zone and breathing zones will be conducted using a direct-reading instrument, as
2 specified in the site-specific safety document, and other methods as deemed appropriate
3 (e.g., pumps with tubes, O₂ meters). The following standards will be used in determining
4 critical levels:

- 5
- 6 • "Radionuclide Concentrations in Air," in Chapter XI, DOE Order 5480.1B
7 (DOE 1986);
- 8
- 9 • "Air Contaminants—Permissible Exposure Limits," in 29 CFR 1910.1000;
- 10
- 11 • *Threshold Limit Values and Biological Exposure Indices for 1990-1991*
12 (ACGIH 1991);
- 13
- 14 • *Occupational Safety and Health Standards*, 29 CFR 1910.1000; and
- 15
- 16 • *Pocket Guide to Chemical Hazards* (NIOSH 1991), which provides National
17 Institute for Occupational Safety and Health (NIOSH)-recommended
18 exposure limits for substances that do not have either a threshold limit
19 value or a permissible exposure limit.
- 20
- 21

22 5.1 AIRBORNE RADIOACTIVE AND RADIATION MONITORING

23
24 An on-site health physics technician will monitor airborne radioactive
25 contamination levels and external radiation levels. Action levels will be consistent with
26 derived air concentrations and applicable guidelines as specified in the radiation
27 protection manual WHC-CM-4-10 (WHC 1988).

28
29 Appropriate respiratory protection shall be required when conditions are such that
30 the airborne contamination levels may exceed an 8-hour derived air concentration (e.g.,
31 the presence of high levels of uncontained, loose contamination on exposed surfaces or
32 operations that may raise excessive levels of dust contaminated with airborne radioactive
33 materials, such as excavation or drilling under extremely dry conditions).

34
35 Specific conditions requiring the use of respiratory protection because of
36 radioactive materials in air will be incorporated into the RWP. If, in the judgement of
37 the health physics technician, any of these conditions arise, work shall cease until
38 appropriate respiratory protection is provided.

6.0 PERSONAL PROTECTIVE EQUIPMENT

The level of personal protective equipment required initially at a site will be specified in the site-specific safety document for each task or group of tasks. Personal protective clothing and respiratory protection shall be selected to limit exposure to anticipated chemical and radiological hazards. Work practices and engineering controls may be used to control exposure.

7.0 SITE CONTROL

The field team leader, site safety officer, and health physics technician are designated to coordinate access control and security on the site. Special site control measures will be necessary to restrict public access. The zones will be clearly marked with rope and/or appropriate signs. The size and shape of the control zone will be dictated by the types of hazards expected, the climatic conditions, and specific operations required.

Control zone boundaries may be increased or decreased based on results of field monitoring, environmental changes, or work technique changes. The site RWP and the contractor's standard operating procedures for radiation protection may also dictate the boundary size and shape. All team members must be surveyed for radioactive contamination when leaving the controlled zone if in a radiation zone.

The on-site command post and staging area will be established near the upwind side of the control zone as determined by an on-site windsock. Exact location for the command post is to be determined just before start of work. Vehicle access, availability of utilities (power and telephone), wind direction, and proximity to sample locations should be considered in establishing a command post location.

8.0 DECONTAMINATION PROCEDURES

Remedial investigation activities will require entry into areas of known chemical and radiological contamination. Consequently, it is possible that personnel and equipment could be contaminated with hazardous chemical and radiological substances.

1 During site activities, potential sources of contamination may include airborne
2 vapors, gases, dust, mists, and aerosols; splashes and spills; walking through contaminated
3 areas; and handling contaminated equipment. Personnel who enter the exclusion zone
4 will be required to go through the appropriate decontamination procedures on leaving
5 the zone. Decontamination procedures shall be consistent with EII 5.4, "Field
6 Decontamination of Drilling, Well Development, and Sampling Equipment," and EII 5.5,
7 "Decontamination of Equipment for RCRA/CERCLA Sampling" (WHC 1991), or other
8 approved decontamination procedures.

9.0 CONTINGENCY AND EMERGENCY RESPONSE PLANS

10
11
12
13
14
15 As a general rule, in the event of an unanticipated, potentially hazardous situation
16 indicated by instrument readings, visible contamination, unusual or excessive odors, or
17 other indications, team members shall temporarily cease operations and move upwind to
18 a predesignated safe area as specified in the site-specific safety documentation.

10.0 REFERENCES

- 19
20
21
22
23
24
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APPENDIX C
PROJECT MANAGEMENT PLAN

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TABLE

C-1	Hanford Site RI/FS Technical Resources
-----	--

ACRONYMS AND ABBREVIATIONS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DOE	U.S. Department of Energy
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FS	feasibility study
MCS	Management Control System
PMP	Project Management Plan
QAPP	quality assurance project plan
RCRA	Resource Conservation Recovery Act
RI	remedial investigation
Tri-Party Agreement	Hanford Federal Facility Agreement and Consent Order
Westinghouse Hanford	Westinghouse Hanford Company

1.0 INTRODUCTION

This Project Management Plan (PMP) defines the administrative and institutional tasks necessary to support the Semi-Works Aggregate Area investigations at the Hanford Site. Also, this PMP defines the responsibilities of the various participants, the organizational structure, and the project tracking and reporting procedures. This PMP is in accordance with the provisions of the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) Action Plan dated August 1990. Any revisions to the Tri-Party Agreement Action Plan that would result in changes to the project management requirements would supersede the provisions of this chapter.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

2.1 INTERFACE OF REGULATORY AUTHORITIES AND THE U.S. DEPARTMENT OF ENERGY

The Semi-Works Aggregate Area consists of active and inactive waste management units to be remedied under either Resource Conservation Recovery Act (RCRA) or Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The U.S. Department of Ecology (Ecology) has been designated as the lead regulatory agency, as defined in the Tri-Party Agreement. Accordingly, Ecology is responsible for overseeing remedial action activity at this aggregate area and ensuring that the applicable authorities of both the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE) are applied. The specific responsibilities of EPA, Ecology, and DOE are detailed in the Tri-Party Agreement Action Plan.

2.2 PROJECT ORGANIZATION AND RESPONSIBILITIES

The project organization for implementing remedial activities at the Semi-Works Aggregate Area is shown on Figure C-1. The following sections describe the responsibilities of the individuals shown on Figure C-1.

2.2.1 Project Managers

The EPA, DOE, and Ecology have each designated one individual as project manager for remedial activities at the Hanford Site. These project managers will serve as the primary point of contact for all activities to be carried out under the Tri-Party Agreement Action Plan. The responsibilities of the project managers are given in Section 4.1 of the Tri-Party Agreement Action Plan.

2.2.2 Unit Managers

As shown on Figure C-1, EPA, DOE, and Ecology will each designate an individual as a unit manager for the Semi-Works Aggregate Area.

The unit manager from Ecology will serve as the lead unit manager. The Ecology unit manager will be responsible for regulatory oversight of all activities required for the Semi-Works Aggregate Area.

The unit manager from EPA will be responsible for making decisions related to issues for which the supporting regulatory agency maintains authority. All such decisions will be made in consideration of recommendations made by the Ecology unit manager.

The unit manager from DOE will be responsible for maintaining and controlling the schedule and budget and keeping the EPA and Ecology unit managers informed as to the status of the activities at the Semi-Works Aggregate Area, particularly the status of agreements and commitments.

2.2.3 Quality Assurance Officer

The quality assurance officer is responsible for monitoring overall environmental restoration program activities through establishment of Hanford Site quality assurance auditing program controls that may be appropriately applied to the remedial activities. The quality assurance officer is specifically vested with the organizational independence and authority to identify conditions adverse to quality, and to systematically seek effective corrective action.

2.2.4 Quality Coordinator

The quality coordinator is responsible for coordinating and monitoring performance of the Quality Assurance Project Plan (QAPP) requirements by means of internal

1 surveillance techniques and by auditing, as directed by the quality assurance officer. The
2 quality coordinator retains the necessary organizational independence and authority to
3 identify conditions adverse to quality, and to inform the technical lead of needed
4 corrective action.

7 **2.2.5 Health and Safety Officer (Environmental Division/Environmental Field Services)**

9 The health and safety officer is responsible for monitoring all potential health and
10 safety hazards, including those associated with radioactive, volatile, and/or toxic
11 compounds during sample handling and sampling decontamination activities. The health
12 and safety officer has the responsibility and authority to halt field activities resulting from
13 unacceptable health and safety hazards.

16 **2.2.6 Technical Lead**

18 The technical lead will be a designated person within the Westinghouse Hanford
19 Company (Westinghouse Hanford) Environmental Engineering Group. The
20 responsibilities of the technical lead will be to plan, authorize, and control work so that it
21 can be completed on schedule and within budget, and to ensure that all planning and
22 work performance activities are technically sound.

25 **2.2.7 Remedial Investigation/Feasibility Study Coordinators**

27 The remedial investigation (RI) and feasibility study (FS) coordinators will be
28 responsible for coordinating all activities related to the RI and FS, respectively, including
29 data collection, analysis, and reporting. The RI and FS coordinators will be responsible
30 for keeping the technical lead informed as to the RI and FS work status and any
31 problems that may arise.

34 **2.2.8 Resource Conservation Recovery Act Facility Investigation/Corrective Measures 35 Study Contractor**

37 Figure C-1 shows the organizational relationship of an offsite contractor. Assuming
38 a contractor is used to perform the RI/FS for the Semi-Works Aggregate Area, the
39 contractor would assume responsibilities of the RI and FS coordinators, as described
40 above. In this instance, the contractor will be directly responsible for planning data
41 collection activities and for analyzing and reporting the results of the data-gathering in
42 the RI and FS reports. However, the Westinghouse Hanford coordinator would retain

1 the responsibility for securing and managing the field sampling efforts of the Hanford
2 Site technical resource teams, described below. Figure C-2 shows a sample
3 organizational structure for an RI/FS contractor team.

6 2.2.9 Hanford Site Technical Resources

7
8 The various technical resources available on the Hanford Site for performing the
9 field studies are shown in Table C-1. These resources will be responsible for performing
10 data collection activities and analyses, and for reporting the results of specific technical
11 activities. Figures C-3 through C-6 show the detailed organizational structure of specific
12 technical teams. Internal and external work orders and subcontractor task orders will be
13 written by the Westinghouse Hanford technical lead to use these technical resources,
14 which are under the control of the technical lead. Statements of work will be provided to
15 the technical teams and will include a discussion of authority and responsibility, a
16 schedule with clearly defined milestones, and a task description including specific
17 requirements. Each technical team will keep the coordinator informed of the work status
18 performed by that group and any problems that may arise.

22 3.0 DOCUMENTATION AND RECORDS

23
24
25 All plans and reports will be categorized as either primary or secondary documents
26 as described by Section 9.1 of the Tri-Party Agreement Action Plan. The process for
27 document review and comment will be as described in Section 9.2 of the Tri-Party
28 Agreement Action Plan. Revisions, should they become necessary after finalization of
29 any document, will be in accordance with Section 9.3 of the Tri-Party Agreement Action
30 Plan. Changes in the work schedule, as well as minor field changes, can be made without
31 having to process a formal revision. The process for making these changes will be as
32 stated in Section 12.0 of the Tri-Party Agreement Action Plan. Administrative records,
33 which must be maintained to support the Hanford Site activities, will be in accordance
34 with Section 9.4 of the Tri-Party Agreement Action Plan.

4.0 FINANCIAL AND PROJECT TRACKING REQUIREMENTS

4.1 MANAGEMENT CONTROL

Westinghouse Hanford will have the overall responsibility for planning and controlling the investigation activities, and providing effective technical, cost, and schedule baseline management. If a contractor is used, the contractor will assume the direct day-to-day responsibilities for these management functions. The management control system used for this project must meet the requirements of DOE Order 4700.1, Project Management System and DOE Order 2250.1C, Cost and Schedule Control Systems Criteria. The Westinghouse Hanford Management Control System (MCS) meets these requirements. The primary goals of the Westinghouse Hanford MCS are to provide methods for planning, authorizing, and controlling work so that it can be completed on schedule and within budget, and to ensure that all planning and work performance activities are technically sound and in conformance with management and quality requirements.

The schedule developed for the Semi-Works Aggregate Area will be updated at least annually, to expand the new current fiscal year and the follow-on year. In addition, any approved schedule changes (see Section 12.0 of the Tri-Party Agreement Action Plan for the formal change control system) would be incorporated at this time, if not previously incorporated. This update will be performed in the fourth quarter of the previous fiscal year (e.g., July to September) for the upcoming current fiscal year. The work schedule can be revised at any time during the year if the need arises, but the changes would be restricted to major changes that would not be suitable for the change control process.

4.2 MEETINGS AND PROGRESS REPORTS

Both project and unit managers must meet periodically to discuss progress, review plans, and address any issues that have arisen. The project managers' meeting will take place at least quarterly, and is discussed in Section 8.1 of the Tri-Party Agreement Action Plan.

Unit managers shall meet monthly to discuss progress, address issues, and review near-term plans pertaining to their respective operable units and/or treatment, storage, and disposal groups/units. The meetings shall be technical in nature, with emphasis on technical issues and work progress. The assigned DOE unit manager for the Semi-Works Aggregate Area will be responsible for preparing revisions to the aggregate area schedule prior to the meeting. The schedule shall address all ongoing activities associated with the

1 Semi-Works Aggregate Area, including actions on specific source units (e.g., sampling).
2 This schedule will be provided to all parties and reviewed at the meeting. Any
3 agreements and commitments (within the unit manager's level of authority) resulting
4 from the meeting will be prepared and signed by all parties as soon as possible after the
5 meeting. Meeting minutes will be issued by the DOE unit manager and will summarize
6 the discussion at the meeting, with information copies given to the project managers.
7 The minutes will be issued within five working days following the meeting. The minutes
8 will include, at a minimum, the following information:

- 9
- 10 • Status of previous agreements and commitments
- 11
- 12 • Any new agreements and commitments
- 13
- 14 • Schedules (with current status noted)
- 15
- 16 • Any approved changes signed off at the meeting in accordance with Section
- 17 12.1 of the Tri-Party Agreement Action Plan.
- 18

19 Project coordinators for each operable unit also will meet on a monthly basis to
20 share information and to discuss progress and problems.

21
22 The DOE shall issue a quarterly progress report for the Hanford Site within 45
23 days following the end of each quarter. Quarters end on March 31, June 30,
24 September 30, and December 31. The quarterly progress reports will be placed in the
25 public information repositories as discussed in Section 10.2 of the Tri-Party Agreement
26 Action Plan. The report shall include the following:

- 27
- 28 • Highlights of significant progress and problems
- 29
- 30 • Technical progress with supporting information, as appropriate
- 31
- 32 • Problem areas with recommended solutions. This will include any anticipated
- 33 delays in meeting schedules, the reason(s) for the potential delay, and actions
- 34 to prevent or minimize the delay
- 35
- 36 • Significant activities planned for the next quarter
- 37
- 38 • Work schedules (with current status noted).
- 39
- 40

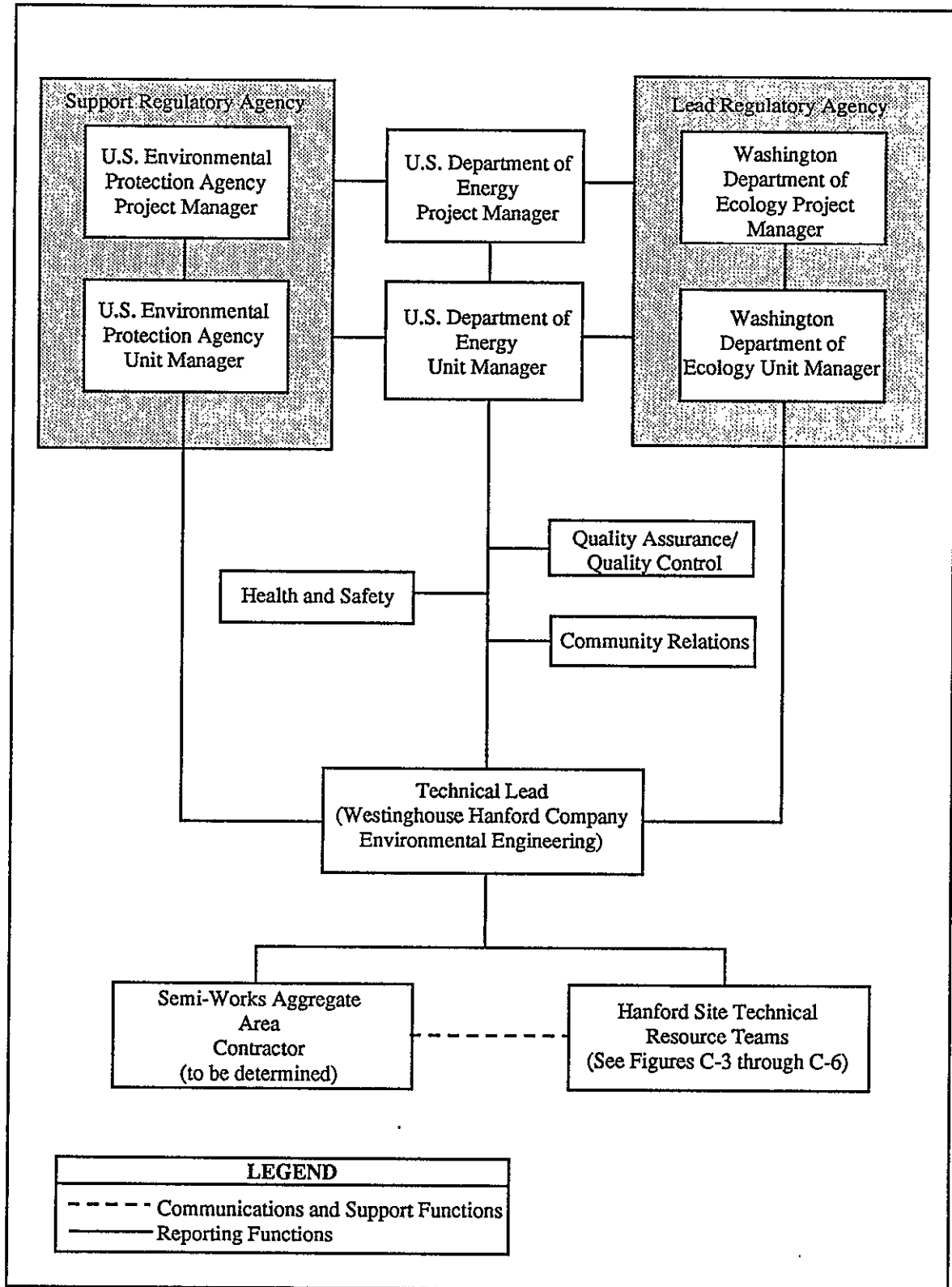


Figure C-1. Project Organization for the Semi-Works Aggregate Area Project.

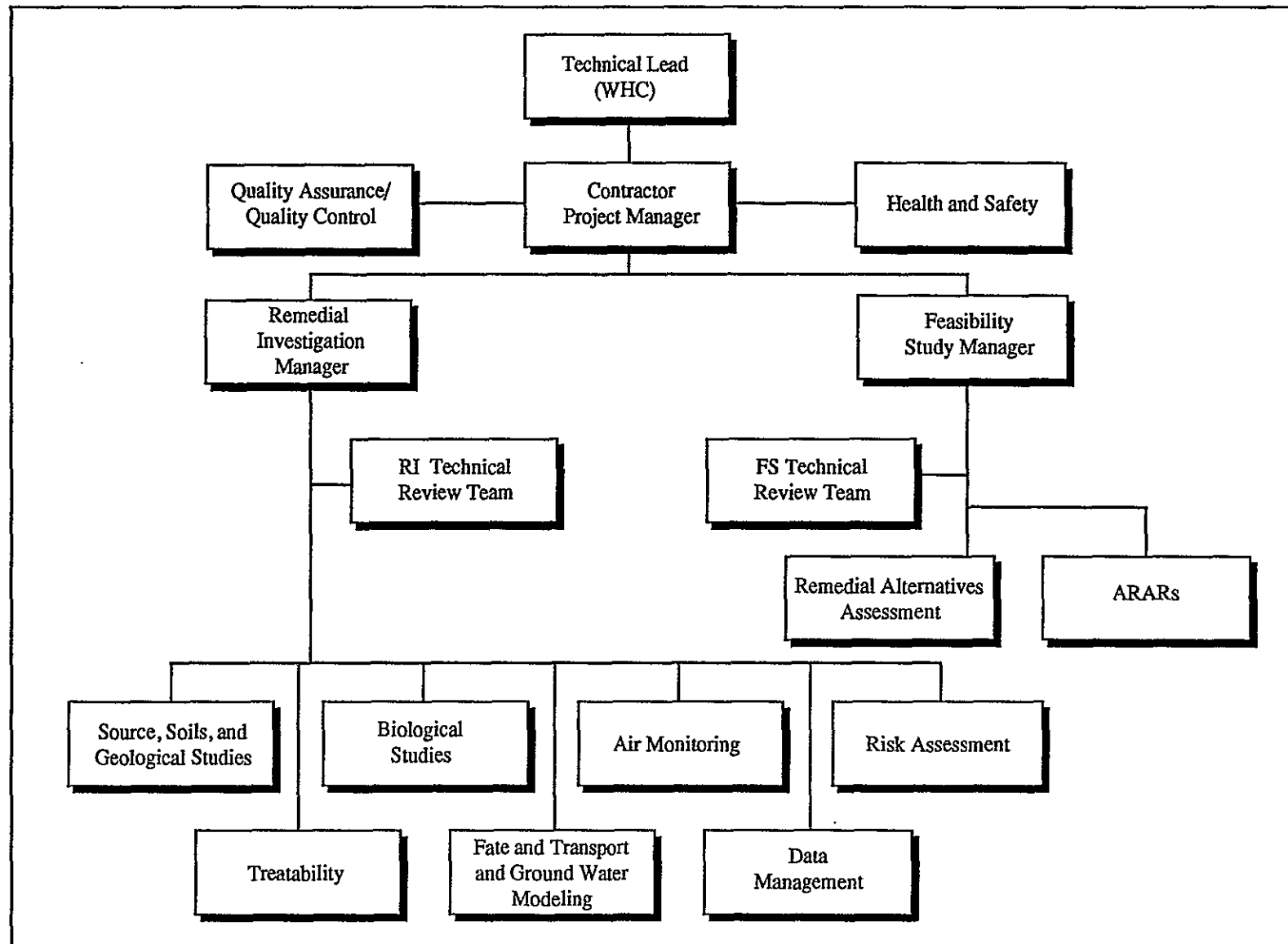


Figure C-2. Example Project Organization for the Semi-Works Aggregate Area

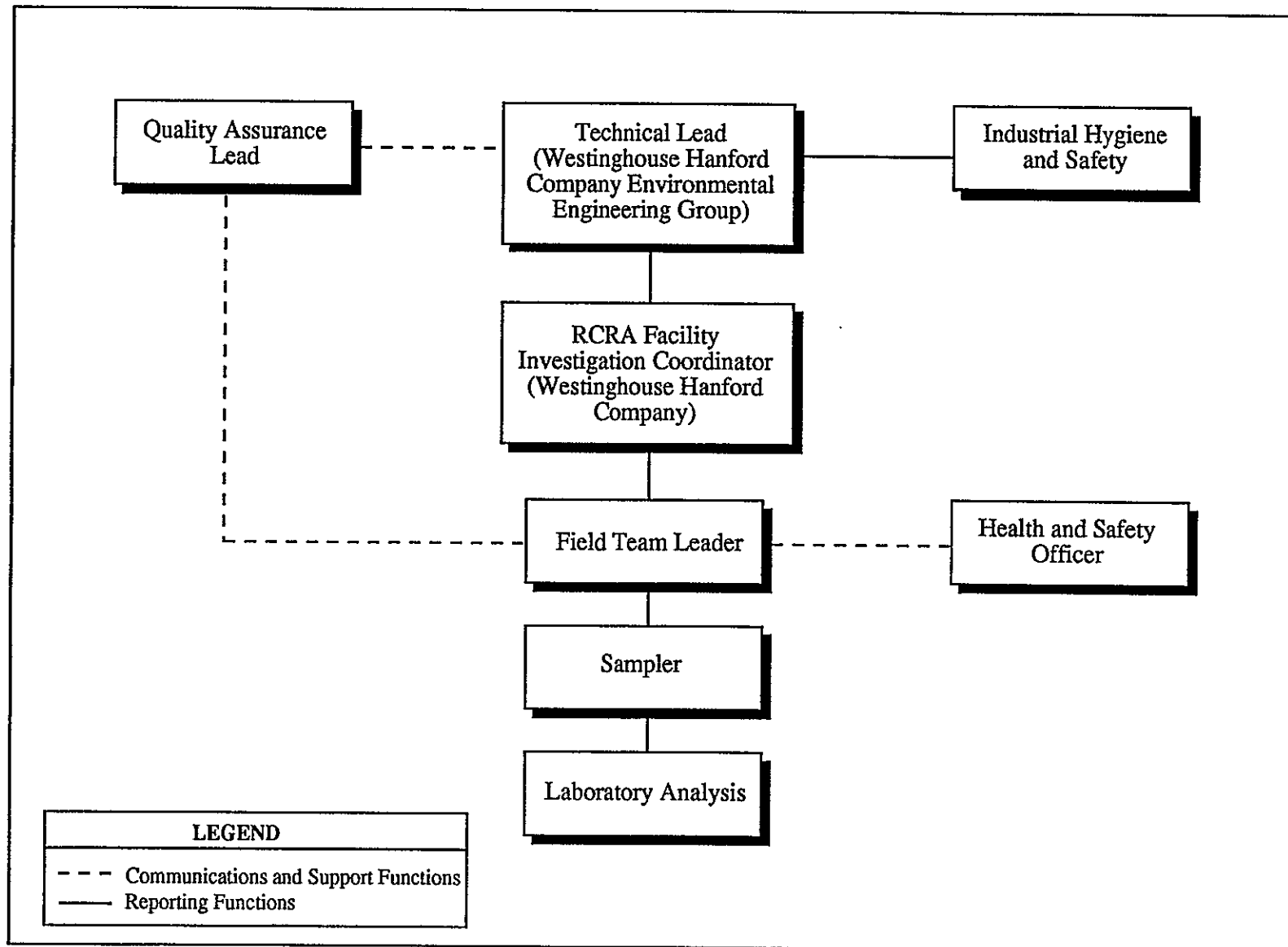


Figure C-3. The Hanford Site Soil Sampling Team.

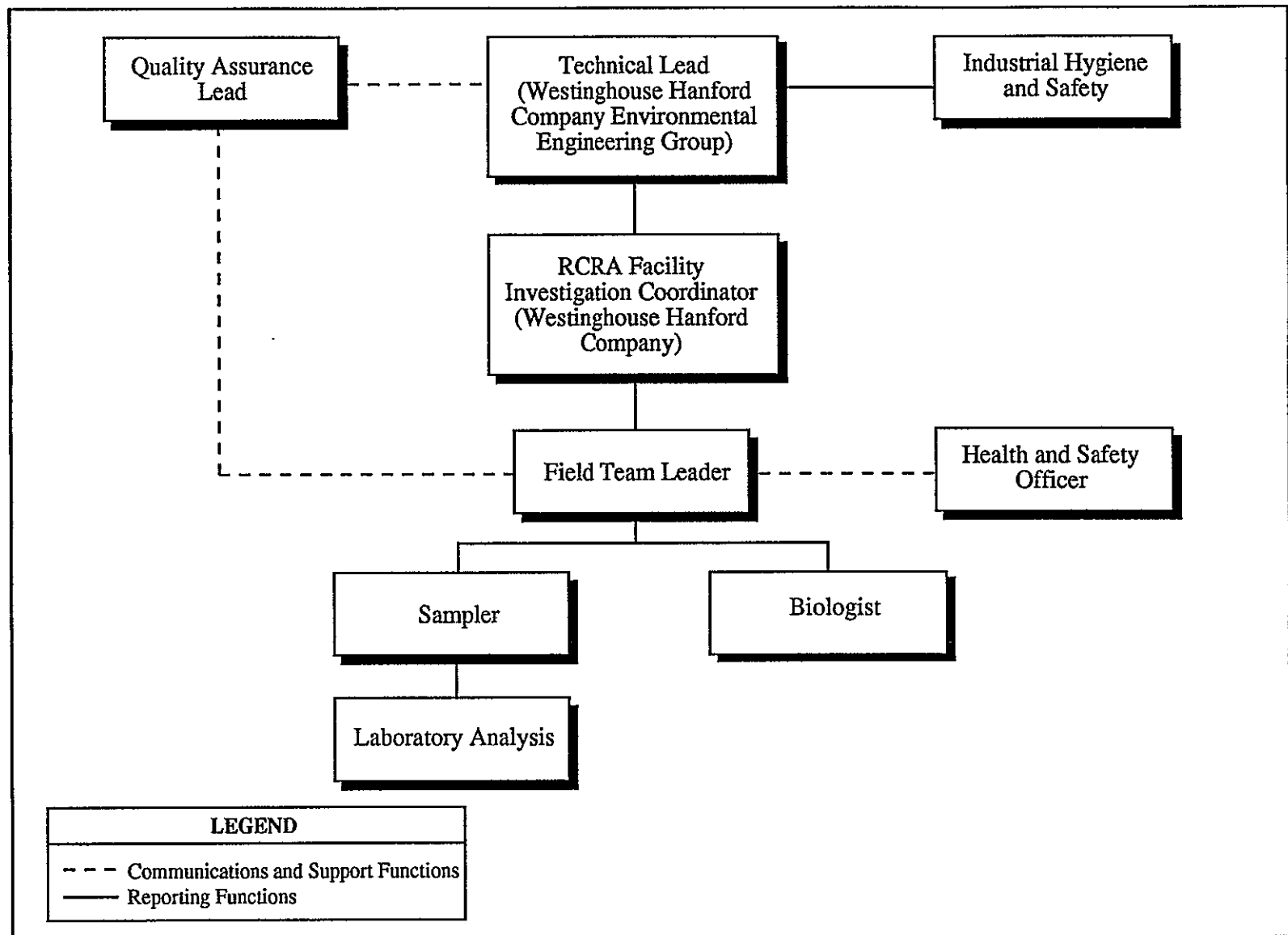
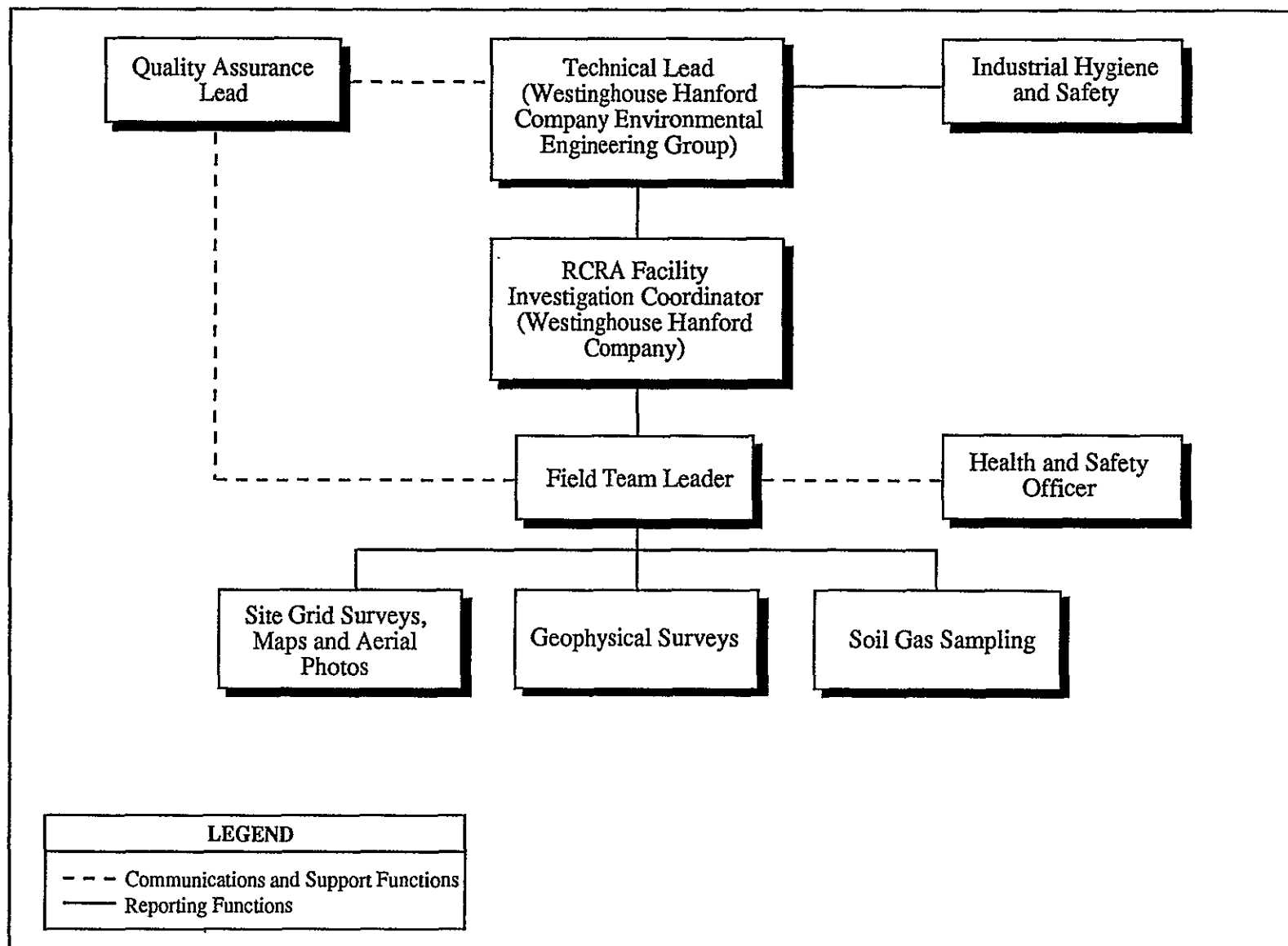


Figure C-4. The Hanford Site Biological Sampling Team.

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Figure C-5. The Hanford Site Physical and Geophysical Survey Team.

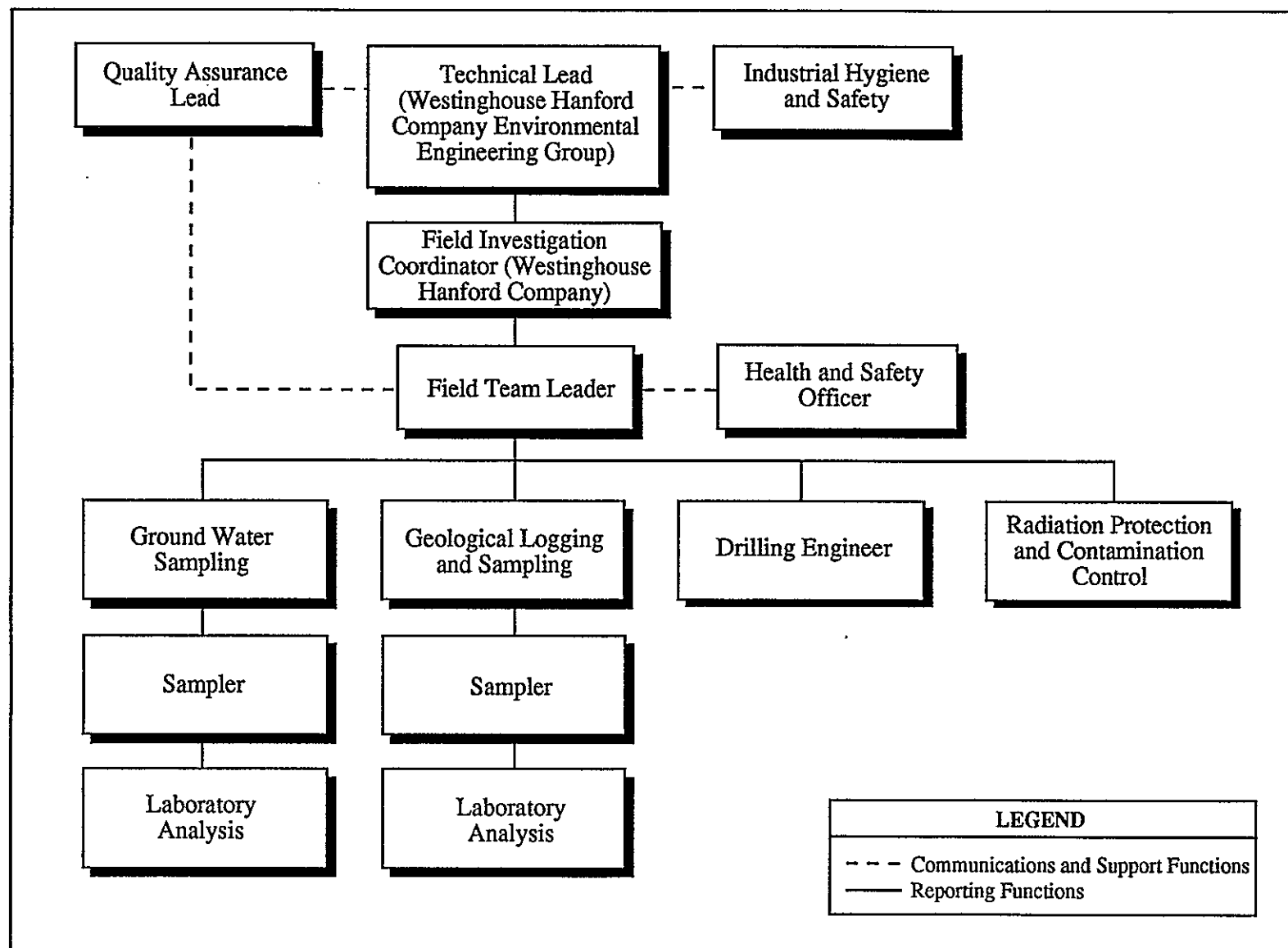


Figure C-6. Drilling, Sampling, and Well-Development Team.

Table C-1. Hanford Site RI/FS Technical Resources. (Page 1 of 2)

Subject/Activity	Technical Resources	
	RI	FS
Hydrology and geology	Westinghouse Hanford/Geosciences PNL/Earth and Environmental Sciences Center	Westinghouse Hanford/Geosciences
Toxicology and risk/endangerment assessment	Westinghouse Hanford/Environmental Technology PNL/Earth and Environmental Sciences Center PNL/Life Sciences Center	Westinghouse Hanford/ Environmental Technology
Environmental chemistry	Westinghouse Hanford/Geosciences PNL/Earth and Environmental Sciences Center	Westinghouse Hanford/Geosciences
Geotechnical and civil engineering	Westinghouse Hanford/Geosciences (Planning) Environmental Field Services	NA
Geotechnical and civil engineering	NA	Westinghouse Hanford/ Environmental Engineering PNL/Waste Technology Center
Groundwater treatment engineering	NA	Westinghouse Hanford/ Environmental Engineering PNL/Waste Technology Center
Waste stabilization and treatment	NA	Westinghouse Hanford/ Environmental Engineering PNL/Waste Technology Center
Surveying	Kaiser Engineers Hanford	NA

Table C-1. Hanford Site RI/FS Technical Resources. (Page 2 of 2)

Subject/Activity	Technical Resources	
	RI	FS
Soil and water sampling and analysis	Westinghouse Hanford/Environmental Engineering Westinghouse Office of Sampling Management PNL/Earth and Environmental Sciences Center PNL/Materials and Chemical Sciences Center	NA
Drilling and well installation	Westinghouse Hanford/Geosciences Environmental Field Services Kaiser Engineers	NA
Radiation monitoring	Westinghouse Hanford/Operational Health Physics	NA

NA = Not applicable.

APPENDIX D
INFORMATION MANAGEMENT OVERVIEW

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D-1 Environmental Engineering, Technology, and Permitting Data Management Model

TABLE

D-1 Types of Related Administrative Data

ACRONYMS AND ABBREVIATIONS

AR	administrative record
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
CMS	Corrective Measures Study
DMP	Data Management Plan
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operations Office
Ecology	Washington State Department of Ecology
EDMC	Environmental Data Management Center
EHPSS	Environmental Health and Pesticide Services Section
EII	Environmental Investigations Instructions
EIMP	Environmental Information Management Plan
EPA	U.S. Environmental Protection Agency
ER	environmental restoration
ERRA	Environmental Restoration Remedial Action
FOMP	Field Office Management Plan
FS	feasibility study
GIS	geographic information system
HEHF	Hanford Environmental Health Foundation
HEIS	Hanford Environmental Information System
HLAN	Hanford Local Area Network
HMS	Hanford Meteorological Station
KEH	Kaiser Engineers Hanford
OSM	Office of Sample Management
PNL	Pacific Northwest Laboratory
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RFI	RCRA Facility Investigation
RI	remedial investigation
ROD	record of decision
TR	training records
Tri-Party Agreement	Hanford Federal Facility Agreement and Consent Order
TSD	treatment, storage, and disposal
Westinghouse Hanford	Westinghouse Hanford Company

DEFINITIONS OF TERMS

Action Plan. Action plan for implementation of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1990). A negotiation between the U.S. Environmental Protection (EPA), the U.S. Department of Energy (DOE), and the State of Washington Department of Ecology (Ecology). The Action Plan defines the methods and processes by which hazardous waste permits will be obtained, and by which closure and post-closure actions under the Resource Conservation and Recovery Act of 1976 (RCRA) and by which remedial actions under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) will be conducted on the Hanford Site.

Administrative Record (AR). In CERCLA, the official file that contains all information that was considered or relied on by the regulatory agency in arriving at a final remedial action decision, as well as all documentation of public participation throughout the process. In RCRA, the official file that contains all documents to support a final RCRA permit determination.

Administrative Record File. The assemblage of documents compiled and maintained by an agency pertaining to a proposed project of administrative action and designated as AR or that are candidates for inclusion in the AR once a record of decision (ROD) is attained.

Data Management. The planning and control of activities affecting data.

Data Quality. The totality of features and characteristics of data that bears on its ability to satisfy a given purpose. The characteristics of major importance are accuracy, precision, completeness, representativeness, and comparability.

Data Validation. The process whereby data are accepted or rejected based on a set of criteria. This aspect of quality assurance involves establishing specified criteria for data validation. The quality assurance project plan (QAPP) must indicate the specified criteria that will be used for data validation.

ENCORE. The name given to the combination of hardware, software, and administrative subsystems that serve to integrate the management of the Hanford Site environmental data.

Environmental Data Management Center (EDMC). The central facility and services that provide a files management system for processing environmental information.

Environmental Information. Data related to the protection or improvement of the Hanford Site environment, including data required to satisfy environmental statutes, applicable DOE orders, or the Tri-Party Agreement.

Field File Custodian. An individual who is responsible for receipt, validation, storage, maintenance, control, and disposition of information or other records generated in support of Environmental Division activities.

Hanford Environmental Information System (HEIS). A computer-based information system

under development as a resource for the storage, analysis, and display of investigative data collected for use in site characterization and remediation activities. Subject areas currently being developed include geophysics/soil gas, vadose zone soil (geologic), atmospherics, and biota.

Information System. Collection of components relate to the management of data and reporting of information. Information systems typically include computer hardware, computer software, operating systems, utilities, procedures, and data.

Lead Agency. The regulatory agency (EPA or Ecology) that is assigned the primary administrative and technical responsibility with respect to actions at a particular operable unit.

Nonrecord Material. Copies of material that are maintained for information, reference, and operating convenience and for which another office has primary responsibility.

Operable Unit. An operable unit at the Hanford Site is a group of land disposal and groundwater sites placed together for the purposes of doing a remedial investigation/ feasibility study. The primary criteria for placement of a site into an operable unit are geographic proximity, similarity of waste characteristics and site types, and the possibility for economies of scale.

Primary Document. A document that contains information on which key decisions are made with respect to the remedial action or permitting process. Primary documents are subject to dispute resolution and are part of the administrative record file.

Project Manager. The individual responsible for implementing the terms and conditions of the Action Plan on behalf of his respective party. The EPA, DOE, and Ecology will each designate one project manager.

Quality Affecting Record. Information contained on any media, including but not limited to, hard copy, sample material, photo copy, and electronic systems, that is complete in terms of appropriate content and that furnishes evidence of the quality of items and/or activities affecting quality.

Quality Assurance. The systematic actions necessary to provide adequate confidence that a material, component, system, process, or facility performs satisfactorily or as planned in service.

Quality Assured Data. Data developed under an integrated program for assurance of the reliability of data.

Raw Data. Unprocessed or unanalyzed information.

Record Validation. A review to determine that records are complete, legible, and meet records requirements. Documents are considered valid records only after the validation process has been completed.

Retention Period. The length of time records must be held before they can be disposed of. The time is usually expressed in years from the date of the record, but may also be expressed as contingent on the occurrence of an event.

Secondary Document. A document providing information that does not, in itself, reflect or support key decisions. A secondary document is subject to review by the regulatory agencies and may be part of the administrative record field. It is not subject to dispute resolution.

Validated Data. Data that meet criteria contained in an approved company procedure.

Verified Data. Data that have been checked for accuracy and consistency following a transfer action (e.g., from manual log to computer, or from distributed database to centralized data repository).

1.0 INTRODUCTION AND OBJECTIVES

1.1 INTRODUCTION

An extensive amount of data will be generated over the next several years in connection with the activities planned for the Semi-Works Aggregate Area. The quality of these data is extremely important to the full remediation of the aggregate area as agreed on by the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA) the Washington Department of Ecology (Ecology), and interested parties.

The Data Management Plan (DMP) provides an overview of the data management activities at the operable unit level. It identifies the type and quantity of data to be collected and references the procedures which control the collection and handling of data. It provides guidance for the data collector, aggregate area investigator, project manager, and reviewer to fulfill their respective roles.

This DMP addresses handling of data generated from activities associated with the aggregate area activities. All data collected will be in accordance with the Environmental Investigations Instructions (EII) contained in the Westinghouse Hanford Company's (Westinghouse Hanford) *Environmental Investigations and Site Characterization Manual* (WHC 1991a).

Development of a comprehensive plan for the management of all environmental data generated at the Hanford Site is under way. The *Environmental Information Management Plan* (EIMP) (Steward et al. 1989), released in March 1989, described activities in the Environmental Data Management Center (EDMC) and long-range goals for management of scientific and technical data. The scientific and technical data part of the EIMP was reviewed, revised, and expanded in fiscal year 1990 (Michael et al. 1990). An *Environmental Restoration Remedial Action Program Records Management Plan* (WHC 1991b) issued in July 1991, enables the program office to identify, control, and maintain the quality assurance (QA), decisional, or regulatory prescribed records generated and used in support of the Environmental Restoration Remedial Action (ERRA) Program.

1.2 OBJECTIVES

This DMP describes the process for the collection and control procedures for validated data, records, documents, correspondence, and other information associated with this aggregate area. This DMP addresses the following:

- Types of data to be collected;
- Plans for managing data;
- Organizations controlling data;
- Databases used to store the data;
- EIMP; and
- Hanford Environmental Information System (HEIS).

2.0 TYPES OF DATA

2.1 TYPES OF DATA

The general types of technical data to be collected and the associated controlling procedures are as follows:

<u>Type of data</u>	<u>Procedure</u>
Historical reports	EII 1.6
Aerial photos	EII 1.6
Chart recordings	EII 1.6
Technical memos	EII 1.6
Validated samples analyses	EII 1.6
Reports	EII 1.6
Logbooks	EII 1.5
Chain-of-custody forms	EII 5.1
Sample quality assurance/ quality control (QA/QC)	Office of Sample Management (OSM)

All such data are submitted to the EDMC for entry into the administrative record (AR).

General types of related administrative data are shown in Table D-1, which is organized in terms of general types of personnel and compliance/regulatory data. Table D-1 references the appropriate procedures and the record custodians. Data associated with aggregate area investigations will be submitted to the EDMC for entry into the AR, as appropriate.

2.2 DATA COLLECTION

Data will be collected according to the aggregate area sampling and analysis plans and the Quality Assurance Project Plan (QAPP). Section 2.1 listed the controlling procedures for data collection and handling before turnover to the organization responsible for data storage. All procedures for data collection shall be approved in compliance with the Westinghouse Hanford *Environmental Investigations and Site Characterization Manual* (WHC 1991a).

2.3 DATA STORAGE AND ACCESS

Data will be handled and stored according to procedures approved in compliance with applicable Westinghouse Hanford procedures (WHC 1988). The EDMC is the central files manager and process facility. All data entering the EDMC will be indexed, recorded, and placed into safe and secure storage. Data designated for placement into the AR will be copied, placed into the Hanford Site AR file, and distributed by the EDMC to the user community. The hard copy files are the primary sources of information; the various electronic data bases are secondary sources.

Normal access to data is through EDMC which is responsible for the AR. The Administrative Record Public Access Room is located in the 345 Hills Street Facility in Richland, Washington. This facility includes AR file documents (including identified guidance documents and technical literature).

Project participants may access data that are not in the AR by requesting it at the monthly unit managers' meeting for the operable unit of concern. As the project moves to completion, it is expected that all of the relevant data will be contained in the AR and the need to access data will be minimal.

The following types of data will be accessed from and reside in locations other than the EDMC:

<u>Data Type</u>	<u>Data Location</u>
• QA/QC laboratory data	OSM (Westinghouse Hanford)
• Sample status	OSM (Westinghouse Hanford)
• Archived samples	Laboratory performing analyses

- Training records Technical Training Support Section
(Westinghouse Hanford)
- Meteorological data Hanford Meteorological Station (HMS) (Pacific
Northwest Laboratory [PNL])
- Health and safety records Hanford Environmental Health Foundation
(HEHF)
- Personal protective fitting Environmental Health and Pesticide Services
Section (Westinghouse Hanford)
- Radiological exposure Pacific Northwest Laboratory.

2.4 DATA QUANTITY

Data quantities for the investigative activities will be estimated based on the sampling and analysis plans developed for investigation of sites within the aggregate area.

3.0 DATA MANAGEMENT PLAN

3.1 OBJECTIVE

A considerable amount of data will be generated through the implementation of the aggregate area sampling and analysis plans. The QAPP will provide the specific procedural direction and control for obtaining and analyzing samples in conformance with requirements to ensure quality data results. The sampling and analysis plans will provide the basis for selecting the location, depth, frequency of collection, etc., of media to be sampled and methods to be employed to obtain samples of selected media for cataloging, shipment, and analysis. Figure D-1 displays the general DMP outline for data generated through work plan activities.

3.2 ORGANIZATIONS CONTROLLING DATA

This section addresses the organizations that will receive data generated from aggregate area activities.

3.2.1 Environmental Engineering Group

The Westinghouse Hanford Environmental Engineering Group provides the operable unit technical coordinator. The technical coordinator is responsible for maintaining and transmitting data to the designated storage facility.

3.2.2 Office of Sample Management

The Westinghouse Hanford OSM and their subcontractors will validate all analytical data packages received from the laboratory. Validated summary data (sample results and copies of chain-of-custody forms) will be forwarded to the technical coordinator. Non-validated data will be forwarded to the technical coordinator on request. Preliminary data will be clearly labeled as such. The OSM will maintain raw sample data, QA/QC laboratory data, and the archived sample index.

3.2.3 Environmental Data Management Center

The EDMC is the Westinghouse Hanford Environmental Division's central facility and service that provides a file management system for processing environmental information. The EDMC manages and controls the AR and Administrative Record Public Access Room at the Hanford Site. Part 1 of the EIMP (Michael et al. 1990) describes the central file system and services provided by the EDMC. The following procedures address data transmittal to the EDMC:

- EII 1.6, Records Management (WHC 1991a)
- EII 1.11, Technical Data Management (WHC 1991a)
- TPA-MP-02, Information Transmittals and Receipt Controls (DOE-RL 1990)
- TPA-MP-07, Administrative Record Collection and Management (DOE-RL 1990).

3.2.4 Information Resource Management

Information Resource Management is the designated records custodian (permanent storage) for Westinghouse Hanford. The procedural link from the EDMC to the Information Resource Management is currently under development.

3.2.5 Hanford Environmental Health Foundation

The HEHF performs the analyses on the nonradiological health and exposure data (Section 3.3.2) and forwards summary reports to the Fire and Protection Group and the Environmental Health and Pesticide Services Section within the Westinghouse Hanford Environmental Division. Nonradiological and health exposure data are maintained also for other Hanford Site contractors (PNL and Kaiser Engineers Hanford [KEH]) associated with aggregate area activities. The HEHF provides summary data to the appropriate site contractor. EII 2.1, Preparation of Hazardous Waste Operations Permits, and EII 2.2, Occupational Health Monitoring (WHC 1991a) address the preparation of health and safety plans and occupational health monitoring, respectively.

3.2.6 Environmental Health and Pesticide Services Section

The Westinghouse Hanford Environmental Health and Pesticide Services Section maintains personal protective equipment fitting records and maintains nonradiological health field exposure and exposure summary reports provided by HEHF for Westinghouse Hanford Environmental Division and subcontractor personnel.

3.2.7 Technical Training Records and Scheduling Section

The Westinghouse Hanford Technical Training Records and Scheduling Section provides training and maintains training records (Section 3.3.4).

3.2.8 Pacific Northwest Laboratory

The PNL operates the HMS and collects and maintains meteorological data (Section 3.3.1). Data management is discussed in Andrews (1988).

The PNL collects and maintains radiation exposure data (Section 3.3.3).

3.3 DATABASES

This section addresses databases that will receive data generated from the aggregate area activities. These and other databases are described in the EIMP (Michael et al. 1990). All of these databases exist independently of this aggregate area and serve other site functions. Data pertinent to the operable unit, housed in these databases, will be submitted to the AR.

3.3.1 Meteorological Data

The HMS collects and maintains meteorological data. Its database contains meteorological data from 1943 to the present, and Andrews (1988) is the document containing meteorological data management information.

3.3.2 Nonradiological Exposure and Medical Records

The HEHF collects and maintains data for all nonradiological exposure records and medical records.

3.3.3 Radiological Exposure Records

The PNL collects and maintains data on occupational radiation exposure. This database contains respiratory personal protective equipment fitting records, work restrictions, and radiation exposure information.

3.3.4 Training Records

Training records for Westinghouse Hanford and subcontractor personnel are managed by the Westinghouse Hanford Technical Training Support Section. Other Hanford Site contractors (PNL and KEH) maintain their own personnel training records. Training records for non-Westinghouse personnel are entered into the Westinghouse (soft reporting) database to document compliance.

Training records include:

- Initial 40-hr hazardous waste worker training
- Annual 8-hr hazardous waste worker training update
- Hazardous waste generator training
- Hazardous waste site-specific training
- Radiation safety training
- Cardiopulmonary resuscitation
- Scott air pack
- Fire extinguisher
- Noise control
- Mask fit.

3.3.5 Environmental Information/Administrative Record

Environmental information and the AR are managed by Westinghouse Hanford EDMC personnel. They provide an index and key information on all data transmitted to the EDMC. This database is used to assist in data retrieval and to produce index lists as required.

3.3.6 Sample Status Tracking

The OSM maintains the sample status tracking database. This database contains information about each sample. Information maintained includes sample number, ship date, receipt date, and laboratory identification.

4.0 ENVIRONMENTAL INFORMATION AND RECORDS MANAGEMENT PLAN

This section briefly discusses the EIMP (Michael et al. 1990) that was developed to provide an overview of an integrated approach to managing Hanford Site environmental data, and the *Environmental Restoration Remedial Action Program Records Management Plan* (WHC 1991b).

4.1 ENVIRONMENTAL INFORMATION MANAGEMENT PLAN

The EIMP provides an overview of how information is managed throughout the lifetime of Hanford Site environmental programs.

The Environmental Division of Westinghouse Hanford is responsible for the protection and improvement of the Hanford Site environment. To fulfill responsibility, the Environmental Division has assumed a management role with respect to Hanford Site environmental information. This management role includes (1) establishing standards for how data are validated and controlled, (2) developing and maintaining a supporting computer-based environment, and (3) sustaining a centralized file management system.

Hanford Site environmental information is defined as data related to the protection or improvement of the Hanford Site environment, including data required to satisfy environmental statutes, applicable DOE orders, or the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1990), (Tri-Party Agreement).

1 Environmental information falls into several overlapping categories, such as
2 administrative versus technical and electronic versus manual or hard copy. A
3 considerable amount of data is recorded in documents, which are governed by
4 company-wide document- and records-control practices. Other data are collected or
5 generated by computer and, therefore, exist in electronic form. The name ENCORE has
6 been given to the combination of administrative, hardware, and software systems that
7 serve to integrate the management of this electronic data.
8

9 Administrative information (e.g., budgets and schedules) is subject to accounting
10 and other standard business practices. Scientific and technical data are subject to a
11 different set of legal, classification, release, and engineering requirements.
12

13 Superimposed over these categories is the files management system for
14 environmental information. This management system, has been developed to meet a
15 number of Environmental Division needs, including requirements for compilation of AR
16 files. The AR files are compilations of all material related to environmental restoration
17 and remedial action records of decision (ROD) for each operable unit and treatment,
18 storage, and disposal (TSD) group described in the Tri-Party Agreement.
19

20 Data in electronic form flow from information systems in the ENCORE realm to
21 both scientific/technical and administrative documents. Environmental documents
22 distributed within the Hanford Site and from regulatory agencies are received by the
23 EDMC for storage and future processing.
24

25 Part I of the EIMP describes the overall Westinghouse Hanford systems that are
26 generally applied to documents and records. Part I also describes, in greater detail, the
27 files management system developed to manage the AR file information. The EDMC
28 compiles the AR files and provides controlled distribution of specified information to the
29 AR files held by DOE, Ecology, and the EPA. The EDMC also provides controlled
30 distribution of specified community relations information to regional information
31 repositories.
32

33 Part II addresses computer-based information, with an emphasis on scientific and
34 technical data. The long-term nature of environmental programs and the complex
35 interrelationships of environmental data require that the data be preserved, retrievable,
36 traceable, and sufficient for future use. To ensure data availability for response to
37 regulatory and agency requirements, the plan is directed toward optimizing the use of
38 automated techniques for managing data. The current processing environment and the
39 proposed ENCORE realm are described, and the plans for implementation of ENCORE
40 are addressed.
41
42

4.2 ENVIRONMENTAL RESTORATION REMEDIAL ACTION PROGRAM RECORDS MANAGEMENT PLAN

The ERRA Program records management plan was developed to fulfill the requirements of the DOE/RL *Environmental Restoration Field Office Management Plan* (FOMP) (DOE/RL 1989). The FOMP describes the plans, organization, and control systems to be used for management of the Hanford Site ERRA Program. The Westinghouse Hanford ERRA Program Office has developed this ERRA Program records management plan to fulfill the requirements of the FOMP. This records management plan will enable the program office to identify, control, and maintain the quality assurance, decisional, or regulatory prescribed records generated and used in support of the ERRA Program.

The ERRA Program records management plan describes how the applicable records management requirements will be implemented for the ERRA Program. The plan also develops the criteria for identifying the appropriate requirements for each individual piece of information related to ERRA work activities.

This records management plan applies to all ERRA Program records and documents generated, used, or maintained in support of ERRA-funded work activities on the Hanford Site. The terms, information, documents, nonrecord material, records, record material, and QA records used throughout the ERRA records management plan are interpreted as ERRA information, ERRA documents, ERRA nonrecord material, ERRA records, ERRA record material, and ERRA QA records.

5.0 HANFORD ENVIRONMENTAL INFORMATION SYSTEM

5.1 OBJECTIVE

The Hanford Environmental Information System (HEIS) has been developed by PNL for Westinghouse Hanford as a primary resource for computerized storage, retrieval, and analysis of quality-assured technical data associated with Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) remedial investigation/feasibility study (RI/FS) activities and RCRA Facility Investigation/Corrective Measures Study (RFI/CMS) activities being undertaken at the Hanford Site. The HEIS will provide a means of interactive access to data sets extracted from other databases relevant to implementation of the Tri-Party Agreement (Ecology et al. 1990). The HEIS will support graphics analysis, including a geographic information system. Implementation of HEIS will serve to ensure that data consistency, quality, traceability,

1 and security are achieved through incorporation of all environmental data within a single
2 controlled database.

3
4 The following is a list of data subjects proposed to be entered into HEIS:

- 5
- 6 • Geologic
- 7 • Geophysics
- 8 • Atmospheric
- 9 • Biotic
- 10 • Site characterization
- 11 • Soil gas
- 12 • Waste site information
- 13 • Surface monitoring
- 14 • Groundwater.

15 16 17 5.2 STATUS OF THE HANFORD ENVIRONMENTAL INFORMATION SYSTEM

18
19 The HEIS, a computerized database containing technical data and information used
20 to support the Hanford environmental restoration (ER) activities, is operational. The
21 data for the Hanford groundwater wells and groundwater samples are currently
22 accessible via the Hanford Local Area Network (HLAN) to local users and to off-site
23 users via a modem link to the HEIS database computer. Additional data, including
24 geologic, biota, and other pertinent environmental sample results, are being entered into
25 the HEIS database.

26
27 The *Hanford Environmental Information System (HEIS) User's Manual* (WHC 1990)
28 was issued in October 1990. An operator manual is being prepared and is expected to
29 be issued in 1992.

30
31 The HEIS geographic information system (GIS) will display detailed maps for the
32 Hanford restoration sites including data from the HEIS database. Such spatially related
33 data will be used to support analysis of waste site technical issues and restoration options.
34 The combination of the HEIS for data and the GIS spatial displays offers some powerful
35 tools for many users to analyze and collectively evaluate the environmental data from the
36 ER and site-wide monitoring programs.

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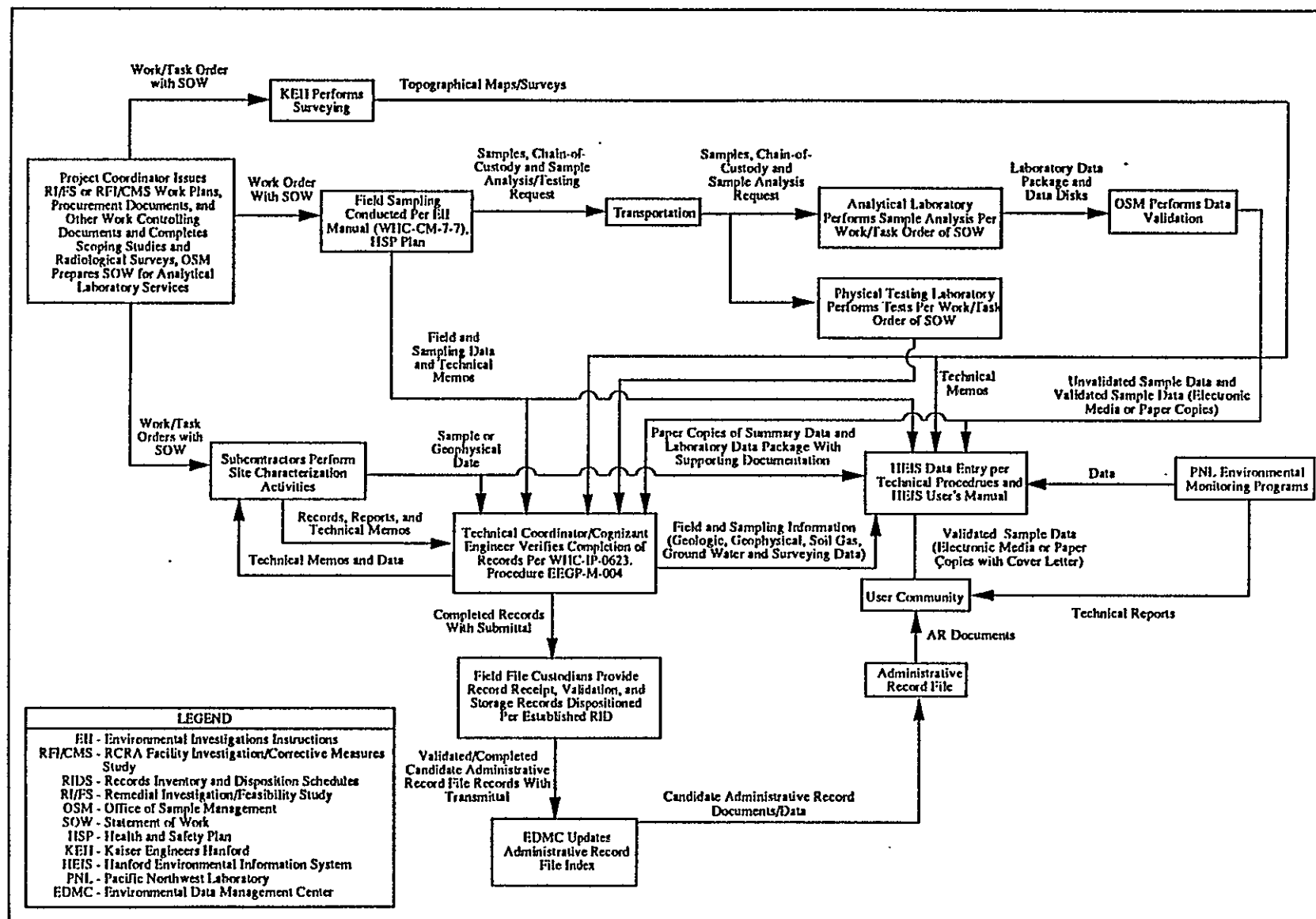


Figure D-1. Environmental Engineering, Technology and Permitting Data Management Model.

Table D-1. Types of Related Administrative Data.

Type of Data	Controlling document/procedure	Record Custodians				
		TR	HEHF	PNL	EDMC	EHPSS
<u>Personnel</u>						
Personnel training and qualifications	EII 1.7 ^{a/}	X				
Occupational exposure records (nonradiological)	EII 2.2 ^{a/}		X			X
Radiological exposure records				X		
Respiratory protection fitting						X
Personnel health and safety records	EII 2.1 ^{a/}		X			X
<u>Compliance/regulatory</u>						
Action-specific requirements/screening levels	EII 1.6 ^{a/}				X	
Guidance document tracking	EII 1.6 ^{a/}				X	
Compliance issues	EII 1.6 ^{a/}				X	
Problem resolution	EII 1.6 ^{a/}				X	
Administrative record	TPA-MP-11 ^{b/}				X	

^{a/} WHC 1991a, *Environmental Investigations and Site Characterization Manual*.

^{b/} DOE-RL 1990, *Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) Handbook*.

EDMC = Environmental Data Management Center (Westinghouse Hanford Company).

EHPSS = Environmental Health and Pesticide Services Section (Westinghouse Hanford Company).

EII = Environmental Investigations Instructions.

HEHF = Hanford Environmental Health Foundation.

TR = Training records (Westinghouse Hanford Company, Pacific Northwest Laboratory [PNL], Kaiser Engineers Hanford [KEH]).